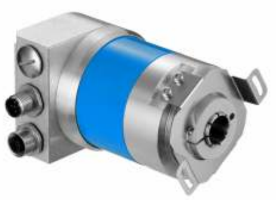
SICK | STEGMANN

Installation & Operating Manual

Absolute rotary shaft encoder ATM60-D (ex. AG626 DN)

to DeviceNet Specification Release 2.0



Imprint

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. Table of Contents

. Summary of Changes

The information below summarizes the changes made to the company since the first edition.

New Information (N)

New features and additional information about existing features.

Updated Information (U)

Changes from the previous release that require you to perform a procedure differently.

Inf.	Changes	Chapter	Rev	Date
	First edition of document		1.00	05/ 2002
	Second changes			

1 Preface

1.1 Using this Manual

This manual gives an overview of the absolute multiturn encoder ATM60-D, and describes how to configure, install, operate and maintain the device on the DeviceNet network.

This manual is intended for qualified personnel responsible for installing, mounting and operating the absolute multiturn encoder ATM60-D in an industrial environment.

You should understand DeviceNet network operations, including how slave devices operate on the network and communicate with a DeviceNet Master. You must have previous experience with and a basic understanding of electrical terminology, programming procedures, networking, required equipment and software, and safety requirements.

1.2 Documentation

The complete documentation contains the following parts:

- Manual for Installation and Operating (IN_ATM60-D_E) **(*)**

(*) This is the documentation on hand.

1.3 Receipt Control

Please examine the following:

- Immediately after delivery, the device for possible damage in transport and defects.
- The number of the parts with the enclosed delivery note.

Don't leave any parts in the packaging.

1.4 Contents of Your Order

You should receive the following items with this package:

- one Manual for Installation and Operating, publication IN_ATM60-D_E
- one encoder ATM60-D with / wo additional DeviceNet adaptor
- one 3.5" software disk, containing EDS File, publication 919-020-00-904

1.5 Storage / Transport

Storing equipment in a dry room.

Storage Temperature -40 °C to +125 °C

Only use the original packaging !

Improper packaging can cause damages during shipment of the equipment.

1.6 Complaint

Claims for compensation which refer to damages during shipment can only be reported if the delivery company (transport supplier) is informed immediately.

Immediately make a damage report for returns (because of damages in transport / repairs). If possible return the parts in the original packaging to the manufacturer.

Enclose the following details in the return:

- Name and address of the sender.
- Address of receiver: -- (see Imprint).
- Part number, description of the defect, contact person for possible questions.

1.7 Guarantee

Please get the guarantee conditions for the encoder ATM60-D from your sales contract. The general warranty and guarantee conditions of **Stegmann GmbH & Co. KG** are valid.

1.8 Symbol Definitions

This symbol indicates text for which you must take particular care that the proper use is ensured and dangers are excluded. Failure to observe these indications could result in physical damages and/ or damage to equipment.

This symbol indicates text which provide important information for the correct use of the encoder. A non-compliance can lead to malfunction of the encoder.

This symbol indicates text giving useful indications and explanations for understanding the document.

2 Terms and Abbreviations

CAN	Controller Area Network	
CiA	CAN in Automation.	
ODVA	Open DeviceNet Vendor Association.	

2.1 Data Specifications

BOOL	Boolean	1 Bit
BYTE	Bit String	1 Byte (8 Bit)
WORD	Bit String	2 Byte (16 Bit)
USINT	Unsigned Short Integer	Int (1 Byte) - (0...255)
UINT	Unsigned Integer	Int (2 Byte) - (0...65.535)
UDINT	Unsigned Double Integer	Int (4 Byte) - (0...+2^{32}.-1)
SINT	Signed Short Integer	Int (1 Byte) - (-128...+127)
INT	Signed Integer	Int (2 Byte) - (-32.768...+32.767)
DINT	Signed Double Integer	Int (4 Byte) - (-2^{31}...+2^{31} - 1)

LSB	Least Significant Bit / Byte,	Example: 81.938$_D$ == [00.01.40.12]$_{hex}$
MSB	Most Significant Bit / Byte,	[00.01.40.12]$_{hex}$
Little Endian	The sequence a number of many places is ordered / transmitted. -- LSB is placed first. -- according example above: { 12.40.01.00 }	
Big Endian	The sequence a number of many places is ordered / transmitted. -- MSB is placed first. -- according example above: { 00.01.40.12 }	

2.2 DeviceNet specific

ID	Identifier
EDS	An electronic data sheet is a vendor-supplied template that dictates how information is displayed as well as what is an appropriate entry.
PM-SC	Predefined Master/ Slave Connection Set
Node	A node is the hardware that has a single address on the network (also referred to as device).
MAC ID	Address of a DeviceNet Node.
Explicit Messaging	This protocol commands the performance of a particular task and returns the result of the task performance to the requester.
IO (I/O)	Means "Input and Output Data".
Input Data	This data is produced by a DeviceNet device (slave) and collected by the scanner (master) and made available for a PLC processor to read.
Output Data	This data is produced by a PLC processor that is written to the scanner's memory. This data is sent by the scanner (master) to DeviceNet devices.

2.3 Encoder specific

CPR (cpr)	Counts per Revolution (steps per turn) -- *Customer specified*
CMR	Number of counts (steps) over the total Measuring Range. -- *Customer specified*
R	Ratio of CMR to CPR. -- R = [CMR] / [CPR] // (adjusted to 2**^{N})
Scaling Parameters	[CMR], [CPR]

PRS	Physical Resolution Span (number of steps per span /revolution) the encoder supports -- assigned Value [8.192] is *Manuf. specified*
PnumRev	Physical Number of Revolutions the encoder supports -- assigned Value [8.192] is *Manuf. specified*
PMR	Physical Measuring Range = [PRS] x [PnumRev]
PM_Bit	correspond to the physical measuring range shown as Bit resolution with "power of 2" (2**$^{PM\_Bit}$) -- The assigned value is **26** (Bit).
PmaxVal	Maximum physical position value correspond to [PMR] minus one (1).

ScF	Scaling Factor = [CPR] / [PRS]
Pos_Scal	Scaled position value, after conversion by the "Scaling Parameters", Offset and Preset-Value
Pos_Phy	Physical (numerical) position value before conversion
CPS	Measuring unit velocity: "Counts (steps) per Sec."
RPS	Measuring unit velocity: "Revolutions per Sec." -- also (rps)
RPM	Measuring unit velocity: "Revolutions per Min." -- also (rpm)

3 Safety Regulations

3.1 Your Responsibilities

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The equipment described in these manuals are intended for use in an industrial environment. Personal injury and damage to equipment can result from not following all applicable safety codes, procedures, and requirements.

As a qualified user or installer of this device, you are responsible for determining the suitability of the product for the intended application. **Stegmann GmbH & Co. KG** is neither responsible nor liable for indirect or any consequential damage resulting from the inappropriate use of this product. The agreed use also includes to adhere the instructions of the valid documentation manuals.

A qualified person or installer is someone who is familiar with all safety requirements and established safety practices relating to the installation, operation, and maintenance of this equipment.

It is recommended that anyone who operates or maintains electrical or mechanical equipment should have a basic knowledge or First Aid.

3.2 Validity and Use

The absolute multiturn encoder ATM60-D is a measuring instrument produced in accordance with recognised industrial regulations and meet the quality requirements of ISO 9001.

The Encoder is a mountable device and cannot be operated independently in his function. Therefore the encoder is not equipped with direct safety facilities. Measures for the security of the plants and personal must executed by the constructor of the plant according the legal guidelines.

The ATM60-D may be used only for the purpose appropriate to its design. This equipment is designed for working at a CAN / DeviceNet network.

The DeviceNet Specification guidelines for the design of a DeviceNet network system must be adhered mandatory.

Mechanical or electrical changes at the equipment are forbidden.

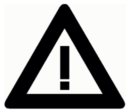
The Encoder has to protected by too high vibrations, strokes, and shocks ! -- Use the appropriate **shock absorber**.

Taking into account, that the following safety labelings, the instruction notes in this document relating to installation and operating must be adhered mandatory.

3.3 Authorised Operators

The installation and maintenance of the encoder is to be carried out by trained and qualified personnel with knowledge of electrical engineering, precision engineering, and programming. They are permitted to install, operate, and maintain the equipment according the standard of security engineering.

3.4 Safety Guidelines and Personal Security



The safety guidelines have to be taken into account, by every person who install, operate, maintain the equipment:

- System and safety documentation must be available and observed at all times.
- Only qualified personnel (familiar with the equipment) are permitted to install, operate, and maintain it.
- All non-qualified personnel are physically restricted from the equipment.
- Systems must be installed in accordance with all applicable safety and regulatory codes.
- Observe the professional safety codes and accident prevention regulations applicable to your country.
- Failure to observe safety procedures could result in personal injury and/ or damage to equipment.
- The Voltage- or Current supplies your equipment is supporting, have been executed according to the valid technical guidelines.

3.5 Safety Labelings for Installation, Operation, Maintenance

- The encoder ATM60-D may be assembled and attached only in a voltage and current-free condition. Switch off the voltage to all the equipment, machines and plants involved in the mounting.
- Never electrically connect or disconnect the encoder with the voltage switched on, otherwise this may lead to damage to the encoder.
- After removing power, check for remaining voltage before making or removing any connections.
- Wiring practices, grounding, disconnects, and over-current protection are of particular importance.
- Check whether the switch-off of the equipment, machines, plants doesn't cause any hazards !
- If necessary, put Warning signs to prevent the unintentional inauguration of the equipment, machines, plants !
- Carry out the assembly / repair work under retention of the correct safety and accident prevention regulations specified by the professional Association.
- Check the correct functions of the safety facilities (e.g. emergency shutdown).
- For the satisfactory operation of the devices, care must be taken to good grounding and to a screen connection suitable for EMC.
- Secure mounting of all moving components before powering a system.
- Avoid striking the shaft or the collet.
- Do not create a program that frequently uses explicit messages to write parameter data to the product. The EEPROM (non-volatile Storage) will quickly exceed its life cycle and cause the product to malfunction.
- Ensure your device is not connected to a live DeviceNet network, while commissioning with a configuration tool.

4 Introduction

4.1 Controller Area Network (CAN)

The ATM60-D is a multiturn absolute encoder using the media "CAN-Bus" for transmission.

The CAN protocol was originally developed by BOSCH for the European automatic market for replacing expensive, wire harnesses with low-cost network cable on automobiles. The CAN Bus system, is gaining more and more acceptance in automation engineering.

CAN does not specify the entire Physical Layer and /or Medium upon which it resides, or the Application Layer protocol used to move data.

- A Media Access Control (MAC) methodology.
- Physical Signalling.

Some specific characteristics of CAN.

- Specification to ISO 11898 (High Speed) and ISO 11519-1 (Low Speed).
- CAN-Specification 2.0 A (11-Bit Identifier) / 2.0 B (29-Bit Identifier).
- Fast response and high transmission security (HD 6)
- Broadcast oriented protocol
- Message oriented protocol with assignment of Identifier (message identification)
- Event-driven data transmission according to CSMA/CA
- Equal-access from each node to the bus
- Line-type bus topology
- Expansion depends on transmission rate
- Use of twisted pair wires with termination resistors at both ends
- max. transmission rate 1 Mbit/s
- Error-tolerant protocol with repetition of messages

4.2 DeviceNet

DeviceNet is a low-cost communication link to connect industrial devices to a network and eliminate expensive hardwiring. The Data Link Layer is completely defined by the CAN Specification and by the implementation of CAN Controller chips.

DeviceNet is an Open network standard. The specification and protocol are open. Anyone may obtain the DeviceNet Specification from the ODVA.

History and main advantages:

- Basic Technology developed by Allen-Bradley, (march 1994)
- Foundation of the ODVA in April 1995, and transfer of the DeviceNet to the ODVA
- A cost effective solution to low-level device networking and engineering
- Easier configuration (only one tool for all devices) and maintenance
- Reliable and secure transmission of data
- Interchangeability of devices between several manufacturer
- Node removal without severing the network

4.2.1 DeviceNet Specification

The DeviceNet Specification defines a network communication system for moving data between elements of an industrial control system. The specification is divided into two volumes.

Volume 1

- DeviceNet Communication Protocol and Application (Layer 7 - Application Layer)
- CAN and its use in DeviceNet (Layer 2 - Data Link Layer)

- DeviceNet Physical Layer and Media (Layer 1 - Physical Layer)

Volume 2

- Device Profiles to obtain interoperability and interchangeability among like products

4.2.2 Technology

DeviceNet uses the CAN technology but specifies more detailed the different layers of the ISO / OSI communication model.

- Layer 2 (Data Link layer) as specified by CAN in ISO 11898 and ISO 11519-1.
- Layer 1 (Physical layer: - Transmission Media)
- Layer 7 (Application layer)

ISO Layer 7	Application Layer	DeviceNet Spec.
ISO Layer 2	Data Link: -- Logical Link Control - (LLC) Data Link: -- Media Access Control - (MAC)	CAN Protocol Spec.
ISO Layer 1	Physical Signalling (PLS) Medium Attachment Unit / Transceiver (MAU) Transmission Media	DeviceNet Spec.

4.2.3 Layout and Characteristics

Shown is the layout and some specific characteristics of DeviceNet:

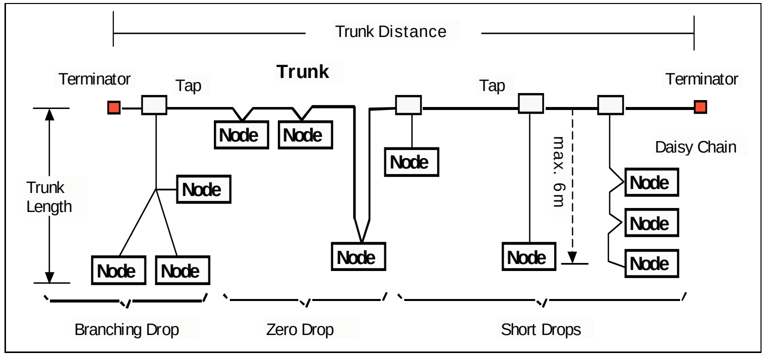


Figure 4–1: Topology of DeviceNet

- Linear Bus Layout with Trunkline and Dropline configuration. -- "Trunk" and "Drops" are topology terms.
- DeviceNet allows branching structures only on the drop line.
- Eligible data rates of 125 kb, 250 kb, 500 kb.
- Support for up to 64 nodes per Network.
- Termination resistors (120 ohms) at both network Trunkline ends.
- Physical media (Shielded Twisted Pair) contains signal and power lines.

- Network power depends on cable (Thick: 8 amps, Thin: 3 amps).
- Use of sealed and open-style connectors.
- Protection from wiring errors.
- Only use of the CAN Specification 2.0 A (11-Bit Identifier).
- Different cable length on Trunkline and Dropline. -- see table below:

Communication Rate	Trunk length		Drop length	
	Thin cable	Thick cable	max. Drop	Cumulative Drop
125 Kbaud	100 m	500 m	6 m	156 m
250 Kbaud	100 m	250 m	6 m	78 m
500 Kbaud	100 m	125 m	6 m	39 m

The cable distance between any two points in the cable system must not exceed the Maximum Cable Distance allowed for the baud rate. Cable distance between two points includes both trunk line cable length and drop line cable length, that exists between the two points.

Drop line length is the longest cable distance of those measured from the tap on the trunk line to each of the transceivers of the nodes on the drop line. This value is limited to 6 m. The total amount (Cumulative Drop) of drop line allowable on the network depends upon the data rate.

4.2.4 Device Profiles

Applications using DeviceNet combine standard or application specific objects together into Device Profiles. The Device Profile fully defines the device as viewed from the network.

A library of objects and Device Profiles is contained in the DeviceNet Specifications. ODVA coordinates the work of industry experts in the development of both new Object and Device Profile Specifications. This is done through Special Interest Groups (SIGs).

There must be a core "standard" for each device type (Profile), so that they:

- exhibit the same behaviour
- produce and /or consume the same basic set of IO-data.
- contain the same basic set of configurable attributes.

A device profile will contain the following:

- Definition of an Object model for the device type.
- Definitions of the IO-data format for the device type.
- Definitions of configurable parameters and public interface(s) to those parameters.

The encoder SIG has the intention to established a device profile for Encoders, to ensure interoperability of their devices. - The following subjects shold be defined:

- measuring principle of absolute and incremental systems.
- mechanical specification of rotary and linear devices.
- functionalities like attributes, services and behaviour to the based object.

Because of ODVA has not approved the profile, device type **"Generic" [00]$_{\text{hex}}$** is used for the identification of the ATM60-D.

4.3 Additional informations

ODVA, DeviceNet
20423 State Road 7
Boca Raton, FL 33498, USA
Tel.: (1) 954-340-5412

CAN in Automation (CiA) e.V.
Am Weichselgarten 26
D-91058 Erlangen
(49) 9131 - 6 90 86-0

email: odva@powerinternet.com
Web: http://www.odva.org http://www.can-cia.de

4.3.1 Related Publications:

- ODVA - Open DeviceNet Vendor Association DeviceNet Specifications Release 2.0
- Device Profile for Encoders, Release 1.00
- DeviceNet Manager Software, User manual 1787 - MGR (1787-6.5.3)
- RSNetWorx for DeviceNet
- DeviceNet Cable System Planning and Installation Manual DN-6.7.2 - May 1999

4.3.2 EDS Web Site:

EDS files are available for downloading at: http://www.stegman.de/ xxx/ eds

5 Operating Modes of the Encoder

The DeviceNet application layer defines how identifiers are assigned and how the CAN data field is used to specify services, move data, and determine its meaning.

All the devices with new data values transmit the corresponding data on the network with a proper Identifier. All devices who needed data listen for messages. When devices recognise the appropriate Identifier, they consume the data. With the Producer-Consumer Model, the message is no longer specific to a particular source or destination.

DeviceNet defines two different types of messaging:

- Explicit messaging
- I/O messaging

5.1 Explicit messaging

The explicit messaging is used for modifying the device configurations, reading diagnostic values, program upload / download, etc.

The ATM60-D supports the fragmented as well as the non-fragmented data transmission.

Characteristics:

- Very flexible
- Less efficient because each device must interpret and generate response
- Contents of the data field:
  - ♦ protocol information
  - ♦ instructions for service to be performed
  - ♦ internal address to which the service is to be applied

5.2 I/O messaging

The I/O messaging is used for fast or time-critical data transfer. All of the 8 data bytes of the CAN message can be used for data transmission. The ATM60-D supports only the non-fragmented data transmission.

Characteristics:

- Less flexible, “Bound” connections
- Highly efficient for both bandwidth and node processing
- Data field only contains data
- Meaning of data is predefined

5.2.1 Input data specification of the ATM60-D

The encoder ATM60-D is an **Input Device**. This means, the encoder only produces data and cannot consume any data from the master.

The ATM60-D supports the following I/O connections (modes), defined within the Predefined Master/ Slave Connection Set (PM-SC). -- (see 8.2).

- Bit Strobed Command/ Response
- Polled Command/ Response
- Change-of-State or Cyclic

Each of the 3 different I/O message connections is assigned its own attribute **"Input Assy_.."**.

Each of these attributes can be assigned to different assemblies simultaneously (1...n).

By default each of the attribute is configured to assembly one (**1**) . -- "Position Value".

The table below shows the characteristics of all data components implemented within the different assemblies.

Data Component	Assembly	activating COS I/O message (x1)	Update cycle time (x2)
Position Value	1, 2, 3, 4	YES	0.250 ms
Flag (Alarm, Warning)	2	YES	0.250 ms
Velocity Value	3	NO	50.000 ms
Cam State	4	YES	0.250 ms

(x1) Possibility to trigger a new message, if the value of the data component has changed.

(x2) Time needed, to calculate a new value for one of the listed data components.

For all the different I/O messages applied, the configured assembly instance determines the data components used as Input Data.

For more detail see section 6.7.5 (Assembly Definitions) and 7.8.6. (Using Assembly)

5.2.2 Polled mode

The standard mode in the Master-Slave communication is the polling mode. In this mode the master contacts all bus participants in a cyclic way. During one scan the output data are transmitted to the slaves and the input data are read from the slaves.

Because the ATM60-D is an Input Device, any output data from the master are ignored. The Poll Command is used to trigger the transmission of return input data in the response message.

5.2.3 COS / Cyclic mode

In Change of State mode the encoder only sends input data if the value of one of the data component, regarding the selected assembly instance, changes. In addition a Cycle Time is used to trigger the transmission of the input data. This is done after the internal Cycle Time period has elapsed, independent of whether one of the data components have changed its value.

Additionally a time delay (production inhibit time) in the range of 1 msec. to 65535 msec. can be configured, to reduce the bus load.

To get a COS message from one of the two data components "Cam State" or "Flag", you should set the parameter value "COS / Hysteresis" to **"0"** (zero), to avoid a trigger from the data component "position value". -- (see also 7.4.7).

In Cyclic mode the encoder only transmit data, after the internal Cycle Time period has elapsed.

5.2.4 Bit Strobed mode

The **Bit Strobed Command**, sends one bit of output data to each Slave whose MAC ID appears in the Master's scan list.

Because the ATM60-D is an Input Device, the output data bit is ignored. The Bit Strobe Command is only used to trigger a transmission of return input data in the response message.

6 DeviceNet Object Model

6.1 Terminology

The configuration data and behaviours implemented in the ATM60-D are defined using object modelling. -- A DeviceNet node is built up as a collection of Objects.

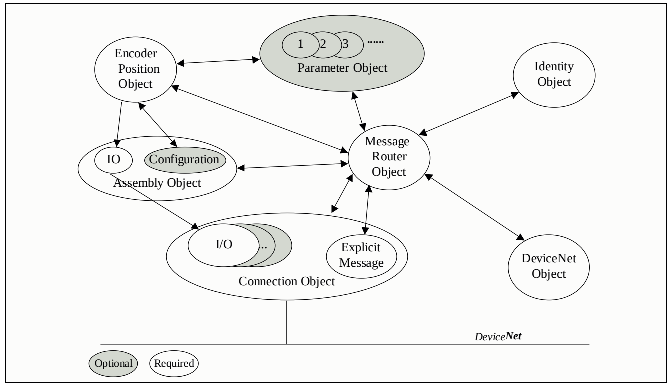


Figure 6–1: Object Model

Used specification of an object:

Term	Means
Object	Representation of a particular type of data component within the DeviceNet node
Instance	Specific occurrence of an Object.
Service	Function (method) performed by an Object.
Attribute	Visible characteristic or feature of an Object.

6.2 Object Addressing

The model provides an addressing scheme for each Attribute consisting of four numbers. This four-level address is used in conjunction with an Explicit Messaging Connection to move data from one place to another on a DeviceNet network.

Component	Description
MAC ID	Unique integer value assigned to each DeviceNet node that distinguishes it specifically from among other nodes. -- (Node address).
Class ID	Unique integer assigned to each Object Class accessible from the network.
Instance ID	Unique identification assigned to an Object Instance that identifies it among all Instances of the same Class.
Attribute ID	Unique identification assigned to a Class attribute and /or Instance attribute.

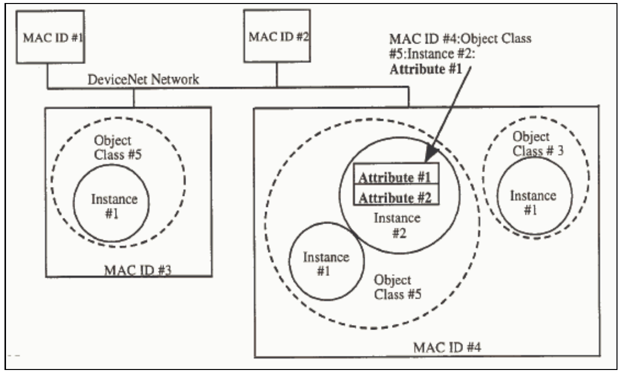


Figure 6–2: Addressing scheme

6.3 Objects of the Encoder

The following objects are supported by the encoder:

Class ID	Object	Description
01_{hex}	Identity	Supports identification, information about the device, and the Reset service.
02_{hex}	Message Router	Processes all messages and routes them to the respective objects.
03_{hex}	DeviceNet	Provides configuration and status attributes of a DeviceNet port.
04_{hex}	Assembly	Combination of attributes from different objects into one object
05_{hex}	Connection	Manages the internal resources associated with both I/O and Explicit Messaging Connections. A Connection Object within a particular module actually represents one of the end-points connection.
$2B_{hex}$	Acknowledge Handler	Controls the receiving of “Acknowledge messages” for message generating objects (e.g. COS connection).
$2F_{hex}$	Encoder	Provides configuration and status attributes of the encoder.

6.4 Identity Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
01_{hex}	Not supported	YES	1	YES

6.4.1 Instance Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description	
1	Vendor ID	Get	UINT	511	STEGMANN
2	Device Type	Get	UINT	**[00]**$_{hex}$	Generic
3	Product Code	Get	UINT	601	AG626 x DN (Switch version)

Attr. ID	Attribute Name	Access Rule	Type	Description	
4	Revision	Get	Struct of USINT	4.01	Major / Minor Revision
5	Status	Get	WORD	Represents status of the entire device	
6	Serial Number	Get	UDINT	Unique identifier for each device	
7	Product Name	Get	SHORT_ STRING	Unique identifier for each product. -- "AG626 Multiturn (Switch Vers)"	
8	State	Get	USINT	Not Supported	
9 (F)	Configur. Consi-stency Value	Get	UINT	Contents identify configuration of device	

6.4.2 Common Services

Service Code	Service Name	Description
05_{hex}	Reset	Reset service for the device (Type: Value = 0)
$0E_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.

6.5 Message Router Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
02_{hex}	Not supported	Not supported	1	Not supported

6.6 DeviceNet Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
03_{hex}	YES	YES	1	YES

6.6.1 Class Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
1	Revision	Get	UINT	Revision of DeviceNet Object (= 2)

6.6.2 Instance Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
1 (X)	MAC-ID	Get / Set	USINT	Node address: (Range 0 – 63)
2 (X)	Baud Rate	Get / Set	USINT	Data Rate (Range 0 – 2)
3	BOI	Get	BOOL	Bus-OFF Interrupt (Default = 0)
4	Bus-OFF-Ctr.	Get / Set	USINT	Number of times CAN went to the Bus-OFF state
5	Allocation Infor-mation	Get	Struct of: USINT	Allocation choice byte, and MAC-ID of Master
6 (F)	MAC-ID Switch changed	Get	BOOL	Node address switch(es) have changed since last power-up/reset.

Attr. ID	Attribute Name	Access Rule	Type	Description
7 (F)	Baud Rate Switch changed	Get	BOOL	Baud Rate switch(es) have changed since last power-up/reset.
8 (F)	MAC-ID Switch Value	Get	USINT	Actual Value of Node address switch(es).
9 (F)	Baud Rate Switch Value	Get	USINT	Actual Value of Baud Rate switch(es).

(X) Set Service is only supported if "Node Commissioning" is configured to *EEPROM*. -- (currently not supported). -- see 7.8

(F) Future use.

6.6.3 Common Services

Service code	Service name	Description
0E$_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.
10$_{hex}$	Set_Attribute_Single	Modifies the specified attribute.

6.6.4 Class specific Services

Service code	Service name	Description
4B$_{hex}$	Allocate_Master / Slave Connection_Set	Request the use of the specified Connection(s).
4C$_{hex}$	Release_Master / Slave Connection_Set	Indicates that the specified Connection(s) of the PM-SC are to be released.

6.7 Assembly Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
04$_{hex}$	YES	YES	4	YES

6.7.1 Class attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
1	Revision	Get	UINT	Revision of this object (= 2)

6.7.2 Instance Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
3	Data	Get	Array of BYTE	Depending the Instance: [1]: Position Value [2]: Position Value + Flags [3]: Position Value + Velocity Value [4] Position Value + Cam State

6.7.3 Common Services

Service code	Service name	Description
0E$_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.

6.7.4 Input Assembly data components

The attributes from different objects are combined to one single assembly object. The table below shows the source of data with object and attribute number.

Data component name	Object / Class		Instance	Attribute	
	Name	Number	Number	Name	Number
Position value	Encoder	0x2F	1	Position value	12
Warning flag	Encoder	0x2F	1	Warning flag	88
Alarm flag	Encoder	0x2F	1	Alarm flag	85
Velocity value	Encoder	0x2F	1	Velocity value	22
Cam state	Encoder	0x2F	1	CAM state register	40

6.7.5 Input Assembly data format

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	Position Value							
	1								
	2								
	3								

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2	0	Position Value							
	1								
	2								
	3								
	4	Flag							
					reserved			Warn	Alarm

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
3	0	Position Value							
	1								
	2								
	3								
	4	Velocity Value							
	5								
	6								
	7								

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
4	0 1 2 3	Position Value							
	4	Cam State							
		Cam 8	Cam 7	Cam 6	Cam 5	Cam 4	Cam 3	Cam 2	Cam 1

6.8 Connection Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
05_{hex}	Not supported	YES	4	YES

The following Connection Objects (Inst. ID) are implemented in the device:

Inst. ID	Instances
1	Group 2 Explicit Message Connection
2	Poll IO Connection
3	Bit Strobed Connection
4	Change of State / Cyclic Connection

6.8.1 Instance Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
1	State	Get	USINT	State of the Connection
2	Instance_Type	Get	USINT	I/O or Explicit Message
3	transportclass_trigger	Get	BYTE	Behaviour of the Connection
4	produced_connection_id	Get	UINT	CAN identifier to transmit on
5	consumed_connection_id	Get	UINT	CAN identifier to receive on
6	initial_comm_characteristics	Get	BYTE	Message Groups associated with this Connection
7	produced_connection_size	Get	UINT	Max. number of bytes transmitted across this Connection
8	consumed_connection_size	Get	UINT	Max. number of bytes received across this Connection.
9	expected_packet_rate	Get / Set	UINT	Timing associated with this Con-nection
12	watchdog_timeout_action	Get	USINT	Defines how to handle Inactivity/ Watchdog time-outs
13	produced_connection_path length	Get	UINT	Number of bytes in attribute "pro-duced_connection_path"
14	produced_connection_path	Get / Set **(*)**	ARRAY of EPATH	Specifies Application Object whose data is to be produced by this Connection.
15	consumed_connection_path length	Get	UINT	Number of bytes in attribute "con-sumed_connection_path"
16	consumed_connection_path	Get	ARRAY of EPATH	Specifies Application Object whose data is to be consumed by this Connection.
17	production_inhibit_time	Get / Set	UINT	Minimum time between new data production for COS connections.

(14) **(*)** The path information refers to the corresponding assembly instance, which is config-ured by the specific attributes "INPUT Assy.." (section 7.8.6). This predefined value can be overwritten within the allocation sequence for this connection. -- (only alterable in the **"configuring state"**).

6.8.2 Services

Service code	Service name	Description
05_{hex}	Reset	Reset the Inactivity Watchdog Timer associated with the Connection Object.
$0E_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_{hex}	Set_Attribute_Single	Modifies the specified attribute.

6.9 Acknowledge Handler Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
$2B_{hex}$	Not supported	YES	1	YES

6.9.1 Instance Attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
1	Acknowledge Timer	Get / Set	UINT	Time to wait for an acknowledge before resending (Default = 16)
2	Retry Limit	Get	USINT	Number of Ack time-outs to wait before informing the producing application.
3	COS Producing connection In-stance	Get	UINT	

6.9.2 Common Services

Service code	Service name	Description
0E$_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.
10$_{hex}$	Set_Attribute_Single	Modifies the specified attribute.

6.10 Encoder Object

Class Code	Class Attributes	Instance Attributes	Number of Instance	Services
2F$_{hex}$	YES	YES	1	YES

6.10.1 Class attributes

Attr . ID	Attribute Name	Access Rule	Type	Description
1	Revision	Get	USINT	Revision of this object (= 01)
2	Max. Instance	Get	USINT	1

6.10.2 Instance attributes

All the following attributes are specified more detailed within section 7. The factory default values are labeled in **bold** type

6.10.2.1 Encoder Basic attributes

Attr . ID	Attribute Name	Access Rule	Type	Description
1	Num. of attributes	Get	USINT	Number of supported attributes
2	Attributes	Get	Array of USINT	List of supported attributes
3	Direction counting (code sequence)	Get Set	BOOL	Direction control for counting. **CW (0)**, CCW (1)
4	Diagnostic control	Get Set	BOOL	Diagnostic Control at encoder stand still. -- Not supported
5	[SFC] Scaling function control	Get Set	BOOL	Physical resolution is converted into a numerical value. -- OFF (0), **ON (1)**
6	Position format	Get Set	USINT	Format of the position attribute - **Steps (0)**
7	[CPR] Measuring units per revolution	Get Set	UDINT	Number of distinguishable steps per revolution. **[20.00]$_{hex}$**
8	[CMR] Total measuring range.	Get Set	UDINT	Steps over the total measuring range in measuring units. -- **[04.00.00.00]$_{hex}$**
9				NOT supported.
10	Preset value	Get Set	UDINT	Current position value is set to Preset Value.
11	COS/delta	Get Set	UDINT	Hysteresis value for position change in COS mode. -- Default value **[5]**
12	Position value	Get	UDINT	Current position value

Attr . ID	Attribute Name	Access Rule	Type	Description
13	Work state area register	Get	UDINT	State of software limit switch position
14	Work area low limit	Get Set	UDINT	Switch point for lower limit - **[00.00.00.00]$_{hex}$**
15	Work area high limit	Get Set	UDINT	Switch point for upper limit **- [03.FF.FF.FF]$_{hex}$**

6.10.2.2 Encoder Extended attributes

Attr . ID	Attribute Name	Access Rule	Type	Description
20	Velocity format	Get Set	USINT	Format of velocity and acceleration attributes CPS (0), **RPM (1)**, RPS (2)
21				NOT supported.
22	Velocity value	Get	DINT	Current speed.
23	Minimum velocity	Get Set	DINT	Limit value for the minimum speed.
24	Maximum velocity	Get Set	DINT	Limit value for the maximum speed.
30				NOT supported.
31	Acceleration value	Get	DINT	Current acceleration
32	Min. acceleration	Get Set	DINT	Limit value for the minimum acceleration.
33	Max. acceleration	Get Set	DINT	Limit value for the maximum acceleration.

6.10.2.3 Cam specific attributes

Attr . ID	Attribute Name	Access Rule	Type	Description
40	CAM state register	Get	BYTE	Current state of the 8 independent cams
41	CAM polarity reg.	Get Set	BYTE	Determines the polarity for each cam. --- range (**[00]$_{hex}$** to [FF]$_{hex}$)
42	CAM enable reg.	Get Set	BYTE	Enable / Disable the 8 independent cams --- range (**[00]$_{hex}$** to [FF]$_{hex}$)
	CAM_No_1			
43	Limit low	Get	UDINT	Switch point for lower limit. Default value = **[00.00.01.00]** $_{hex}$
44	Limit high	Get	UDINT	Switch point for higher limit. Default value = **[03.FF.FC.00]** $_{hex}$
45	Hysteresis	Get	UINT	Delay setting of switch points. Default value = **[00.20]** $_{hex}$
	Cam_No_2			ID 46, 47, 48 -- (see 43, 44, 45)
	Cam_No_3			ID 49, 50, 51 -- (see 43, 44, 45)
	Cam_No_4			ID 52, 53, 54 -- (see 43, 44, 45)
	Cam_No_5			ID 55, 56, 57 -- (see 43, 44, 45)
	Cam_No_6			ID 58, 59, 60 -- (see 43, 44, 45)
	Cam_No_7			ID 61, 62, 63 -- (see 43, 44, 45)
	Cam_No_8			ID 64, 65, 66 -- (see 43, 44, 45)

6.10.2.4 Diagnostic attributes

Attr. ID	Attribute Name	Access Rule	Type	Description
80	Operating status	Get	BYTE	Encoder operating status regarding some encoder basic attributes.
81	Physical Resolution Span	Get	UDINT	Single Turn Resolution means "Steps per Revolution" the encoder supports.
82	NumRev	Get	UINT	Number of revolutions the encoder supports.
83	Alarms	Get	WORD	See (7.7.4) "Alarm functionality"
84	Supported alarms	Get	WORD	See (7.7.4)
85	Alarm flag	Get	BOOL	See (7.7.4)
86	Warnings	Get	WORD	See (7.7.5) "Warning functionality"
87	Supp. warnings	Get	WORD	See (7.7.5)
88	Warning flag	Get	BOOL	See (7.7.5)
89	Vers. (Profile, SW)	Get	UDINT	See (7.7.6) -- Profile and Software Version
90	Operating Time	Get	UDINT	operating time for the encoder in operating hours (0,1 hours). -- See (7.7.7)
91	Offset Value	Get	UDINT	calculated by PRESET function. See (7.7.8).
92				NOT supported.
93 /94	Manuf. Min./ Max. Position Value	Get	UDINT	Manufacturer minimum / maximum Position Value (steps) -- See (7.7.9)
95	Encoder type	Get	UINT	Specifies the encoder type -- See (7.7.9)

6.10.3 Manufacturer specific attributes

These attributes are not specified in this object. -- See description in chapter 7.8.

6.10.4 Common Services

Service code	Service name	Description
$0E_{hex}$	Get_Attribute_Single	Returns the contents of the specified attribute.
10_{hex}	Set_Attribute_Single	Modifies the specified attribute.
05_{hex}	Reset	Sets all parameters to manufacturer default values
15_{hex}	Restore	Sets all parameters to the EEPROM values
16_{hex}	Save	Save all parameters values to the EEPROM

7 Encoder Object Parameters

7.1 General Conditions to use the Scaling Function

7.1.1 Specification for using encoder in "Continuous Mode"

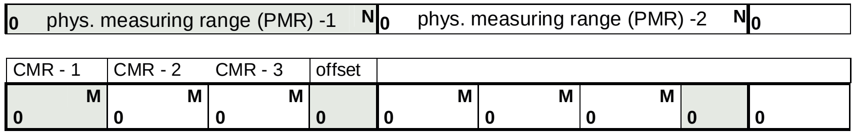
If a absolute rotary encoder exceeds the physical measuring range [PMR] it continues counting with either its minimum value [PminVal] (0) or its maximum value [PmaxVal] depending on the direction of rotation. A successive counting regarding the position readout, is only ensured if the scaled measuring range [CMR] is an integral multiple of [PMR]. Mapping the [CMR] to [PMR] with an **offset**, will result in a faulty scaled position value (no steady counting). -- Possible solutions:

- Map the scaled measuring range completely into the physical measuring range (No resulting **offset**). This means a possible adjustment of the configured CMR value.
- Map the scaled measuring range into the physical measuring range. The resulting **offset** must always be adjusted, the physical measuring range exceeds / fall below the limits. The offset value must be saved to a non volatile RAM (EEPROM) to ensure the correct conversion from physical to scaled position values after a Switch-Off.

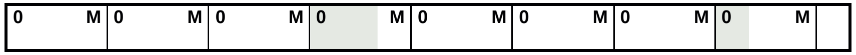
The following view shows an example of the relationship between the two measuring ranges.

[0...N] = minimum / maximum values of the physical measuring range.

[0...M] = minimum / maximum values of the scaled measuring range.



Without consideration of the resulting offset, the scaled position values are no longer correct, the encoder changes from one into the next physical measuring range.



The offset is used to calculate a correct scaled position value. By changing from one into the next physical measuring range the offset value itself must be adjusted.

7.1.2 Scaling Mode without Limitation to the measuring range

The scaled measuring range is mapped into the physical measuring range. A possible resulting **offset** is used to ensure the correct conversion from physical position values to scaled position values. The customer specified value for CMR is not adjusted to cause a "power of two" value for the ratio of CMR to CPR. -- The following limitations are specified:

- Ratio CMR to CPR (R) must be greater or equal **1**.
- CMR must be less or equal the physical measuring range the encoder is supporting.

	This functionality is currently **Not** implemented in the ATM60-D!

7.1.3 Adjusted Scaling Mode

The scaled measuring range is completely mapped into the physical measuring range. The customer specified value for CMR is adjusted to cause a "power of two" value for the ratio of CMR to CPR (no **offset** is caused). -- Furthermore, the following adjustments are valid:

- $1 \leq R \leq$ **2^{**N}**, (with $1 \leq N \leq 13$), R= CMR/ CPR
- CMR ≤ PMR.

Table below shows some configurations of adjustments to meet the specified limitations.

Customer specified CPR	Customer specified CMR	Adjusted values CPR	Adjusted values CMR	ScF	R = 2^N
8.192	67.108.864	8.192	67.108.864	1	2^{13}
8.192	67.108.863... 33.544.432	8.192	33.544.432 (2^{25})	1	2^{12}
8.192	33.544.431... 16.777.216	8.192	16.777.216 (2^{24})	1	2^{11}
8.192	16.383... 8.192	8.192	8.192 (2^{13})	1	1
8.192	8.191... 1	8.192	8.192 (2^{13})	1	1
4.096	67.108.864	4.096	33.544.432 (2^{25})	1/2	2^{13}
4.096	67.108.863... 33.544.432	4.096	33.544.432 (2^{25})	1/2	2^{13}
4.096	33.544.431... 16.777.216	4.096	16.777.216 (2^{24})	1/2	2^{12}
2.730 (x1)	67.108.864... 33.544.432	2.730	22.364.160	1/3 (*)	2^{13}
2.730 (x1)	33.544.431... 22.364.160	2.730	22.364.160	1/3 (*)	2^{13}
2.730 (x1)	22.364.179... 11.182.080	2.730	11.182.080	1/3 (*)	2^{12}
2.048	67.108.864	2.048	16.777.216 (2^{24})	1/4	2^{13}
2.048	67.108.863... 16.777.216	2.048	16.777.216 (2^{24})	1/4	2^{13}
2.048	16.777.215... 8.388.608	2.048	8.388.608 (2^{23})	1/4	2^{12}
1.000 (x1)	67.108.864	1.000	8.192.000	1/n (*)	2^{13}
1.000 (x1)	67.108.863... 8.192.000	1.000	8.192.000	1/n (*)	2^{13}
1.000 (x1)	(8.192.000-1)... 4.096.000	1.000	4.096.000	1/n (*)	2^{12}

(x1) Value is no "power of two", and means the scaling factor never gives a integral result.

Examples (a, b) for the conversion into a scaled position value:

	Customer specified CPR	Customer specified CMR	Adjusted values CPR	Adjusted values CMR_a	ScF	R = 2^N
a	4.096	33.544.431... 16.777.216	4.096	16.777.216	1/2	2^{12}
b	2.730 (x1)	33.544.431... 22.364.160	2.730	22.364.160	1/3 (*)	2^{13}

- physical position value (Pos_Phy): >>67.108.863<< (max. value)

Pos_Scal = (Pos_Phy **x** ScF) **%** CMR_a

a Pos_Scal = (67.108.863 **x** 1/2) **%** 16.777.216 = <u>16.777.215</u>
b Pos_Scal = (67.108.863 **x [2.730/ 8.192]**) **%** 22.364.160 = <u>22.364.159</u>

This means the max. physical position value the encoder is supporting, also correspond to the max. value within the scaled measuring range.

7.2 Saving Encoder Parameters

Writeable attributes could be changed within the corresponding range. Generally a changed value is **not** automatically saved to EEPROM. If the value should be validate after a Power Off/On, you have to **save** the value to the EEPROM, using a special command within your configuration tool. RSNetWorx supports this command with the "Class Instance Editor", accessing the service command **"save"** (16_{hex}) of the encoder object. -- see 9.2.6.

During the save operation (approx. **<u>300 ms</u>**.), the evaluation of CAN messages are blocked.

Saving encoder specific attributes to EEPROM.

The following attributes are saved immediately to the EEPROM.

Attribute	Process
"Offset Value"	Preset Button has been pressed or number of "Preset value" has been changed via protocol to set a new position value.
"Preset Value"	
	Manufacturer specific attributes, to select an assembly instance for
"Ass_Num_Poll" (111)	Polling mode
"Ass_Num_COS" (112)	COS / Cyclic mode
"Ass_Num_BIT" (113)	BIT Strobed mode

7.3 General Explanations to the Encoder Attributes

With the Explicit messaging the customer can configure the parameters of the encoder for his particular application. The parameters are established as attributes within the encoder object. To configure these attributes you usually use a Configuration Software Tool like "DeviceNet Manager" or "RS-NetWorx".

The numbering of the attributes in this section does not refer to the ID numbers of the parameters shown by a configuration tool (using EDS parameter numbering), but only reflect the numbering of the encoder object.

The parameters (attributes) of the encoder object can get subdivided into different sections. For a general summary see also 6.10.2 (Encoder Profile...)

- Basic Attributes (Scaling parameters, Scaling Control, Preset Value,...)
- Extended Attributes (Work area, Velocity, Acceleration)
- Functionality of one Channel with 8 Cams
- Diagnostic Functions
- Manufacturer specific Attributes.

- All the values with position details of the following parameters specified within the encoder object must be within the total working range currently configured by the CMR value.
- If several parameters will be modified online, side effects can occur. The user must take care of that.

7.4 Encoder - Basic Attributes

7.4.1 Direction counting / Code sequence

Direction control for counting. This attribute defines whether increasing or decreasing position values are output when the encoder shaft rotates clockwise or counter-clockwise when looking at the end of the shaft.

7.4.2 Diagnostic Control

With this function it is possible to check the encoder components responsible for position detection at encoder stand still. For the ATM60-D the diagnostic detection is permanently activated and shows the result by the Warning / Alarm flag. -- This attribute has NO meaning for the equipment.

7.4.3 Scaling Function Control -- [SFC]

When this parameter is set to ON (1), the physical (numerical) position value of the encoder is converted by software into the scaled value. If this parameter is set to OFF (0), the scaling function is disabled.

7.4.4 Measuring units per revolution -- [CPR]

This parameter sets the number of distinguishable counts per revolution. The factory default value corresponds to the physical resolution per span.

An internal scaling factor **(ScF)** is generated by this value and "Physical Resolution per Span". (see 2.3 Terms..)

7.4.5 Total measuring range in measuring units -- [CMR]

This parameter sets the number of distinguishable counts (steps) over the total measuring range, and correspond to the scaled measuring range.

Conditioned to the implementation of the **adjusted scaling mode** (see 7.1.3) this parameter will be adjusted by the system internally. The adjusted value is always less or equal the configured value.

7.4.6 PRESET Value

The Preset function supports adaptation of the encoder zero point to the mechanical zero point of the encoder system.

The current position value is set to this value. This and the resulting "Offset Value" (difference from current to physical position value) are both saved **automatically** to the EEPROM.

The Preset Value is not automatically adjusted, if the "Scaling Parameters" (CPR, CMR) have changed. Therefore this attribute must be adjusted by the user to ensure the numerical value lie inside valid limits.

7.4.7 COS/ delta

The attribute supports a hysteresis value for a position change indication in the COS mode. A new position value is only valid / transmitted, if the change in position (Pos_Scal) is greater or equal than this value.

Setting this value number to zero ("0"), means any changes of the calculated position value are ignored, and **no** message by a position change is transmitted. This is useful to get a COS message by another data component like "Flag" or "Cam state". -- (see also 5.2.3).

7.4.8 Position Value

Current position value. The content is based upon the "Scaling parameters", SFC, and the PRESET Value.

"Position Value" is implemented as the standard data component in all the assembly instances (1 - 4).

The position value is built internally by the system according the following equation. If the scaling function is disabled, the value for ScF is set to one (1), also the value CMR correspond to PMR. The Offset Value is determined by the configured Preset Value.

Pos_Scal = (Pos_Phy **-** "Offset Value") **x** ScF **+** "Preset Value"

View of the 4 Byte position value regarding the bit assignment. Shown is the maximum measuring range the encoder supports, partitioned into 2 ranges.

Byte_3 (MsB)		Byte_2	Byte_1		Byte_0 (LsB)
31 30 29 28 27 26	25 24	23 22 21 20 19 18 17 16	15 14 13	12 11 10 09 08	07 06 05 04 03 02 01 00
	number of revolutions			CPR (1...8192) - [counts p Revol.]	
	[CMR]				

View of the 4 Byte "Position Value" according a data mapping in format "Little Endian" used by the DeviceNet transmission protocol.

Byte_0 (LsB)		Byte_1		Byte_2		Byte_3 (MsB)		
1	2	4	0	0	1	0	0	81.938_D == $[00.01.40.12]_{hex}$

7.5 Encoder - Extended Attributes

7.5.1 Work area register (Attr. 13, 14, 15)

The actual work area information with work area low limit and work area high limit can be configured in these attributes. The "area state register" (Attr. 13) contains the actual area status of the encoder position. If the position is out of range, a bit will be set in the related position line.

Current Position	Limits	"area state register"
fall below	"work area low limit" (Attr. 14)	Bit 2 flags "underflow"
exceed	"work area high limit" (Attr. 15)	Bit 1 flags "overflow"
fall below or exceed	"manufacturer Min. position value" "manufacturer Max. position value"	Bit 0 flags "out of range"

7.5.2 General velocity and acceleration parameter

Attribute 20 determines the display format of the velocity and acceleration values. By changing the type of format, all the corresponding values (minimum and maximum limits, current results) are adjusted to the specified format.

Attribute	Range of values	Default
(20): velocity format	CPS (counts (steps)/ Sec) [0] || RPM [1] || RPS [2]	RPM
(23): Minimum velocity	{0 - 819.200} CPS || {0 - 6000 RPM} || {0 - 100} RPS	0
(24): Maximum velocity		6000
(32): Min. acceleration	velocity values (see above) x 10 related to [sec.]	0
(33): Max. acceleration		60.000
(22): velocity value	current result: -- {0 - 6000 } RPM	
(31): acceleration value	current result: -- {0 - 60.000 } RPM / sec	

7.5.3 Velocity value (Attr. 22)

The calculation of the velocity value is based on the numerical position values and updated in cycles of 50 ms. To eliminate short-term fluctuations, an integration time of 1 sec. is used for the measuring.

The velocity value is signed. By changing the direction of rotation or by changing the value of code sequence (Attr. 3), the sign of the velocity value also changes (+/-).

Table below shows the view of the value in dependence of the velocity format.

Byte 3	Byte 2	Byte 1	Byte 0		
				minimum limit (dec.)	format
00	00	00	00	00	CPS, RPM, RPS
				maximum limit (dec.)	format
00	0C	80	00	819.200	CPS (steps/ Sec)
FF	F3	80	00	- 819.200	CPS (steps/ Sec)
00	00	17	70	6000	RPM
FF	FF	E8	90	- 6000	RPM
00	00	17	64	100	RPS
FF	FF	FF	9C	- 100	RPS

"Velocity Value" is implemented as data component in assembly instance [3].

7.5.4 Acceleration value (Attr. 31)

Acceleration is defined as a changing of velocity (speed) per time unit. The used time unit is always **[sec]**. -- This means the acceleration value is given in "velocity format" per [sec].

The "acceleration value" can not be read via an I/O message, but can only be accessed via an explicit message.

The current acceleration value (Attr. 31) is derived from the calculated velocity value and updated in the same cycle time as done for the velocity calculation. The value is also signed with the following meaning.

Value (sign)	Explanation
0	Velocity is constant
+	Velocity is increasing
-	Velocity is decreasing (slow down)

7.6 Encoder - Functionality of Cam Channels

7.6.1 Usage of the Cams

The encoder device supports one channel with 8 different cams. Each cam has parameters for the minimum switch point, the maximum switch point and setting a hysteresis to the switch points.

You have to set a hysteresis value, to avoid permanent switching in case of the current position value is fluctuating round the switch point. The hysteresis value is used as an offset to shift the limits into the opposite direction. A following turning back of the current position value is now compared with the shifted limit value.

"Cam Channel State Register." is implemented as data component in assembly instance no. 4.

The table below shows how a current position value is compared with the adjusted switch points, in dependence of the previous state of the position value.

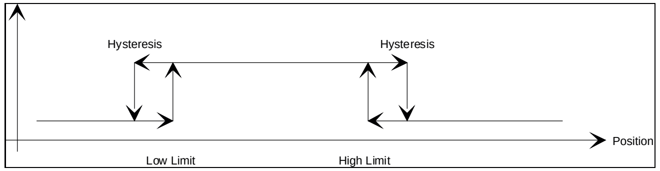


Figure 7–1: Usage of the Hysteresis

previous position / state	Min. switch point (LOW)	Max. switch point (HIGH)
within switch points / (1)	Low Limit - Hysteresis	High Limit + Hysteresis
outside switch points / (0)	Low Limit	High Limit

The values of limit low, limit high, and hysteresis are checked against each other. Bit no. 13 of attribute "warnings" indicates to any of the configured cams an illegal configuration to these values.

The warning "Cam_xx limits" (high, low) **out of order** is set in the following cases:

- hysteresis value is greater than value "low Limit".
- the values "low Limit" / "high Limit" are greater than the "Total Measuring Range" (CMR).

A mutual exchange of the values "low Limit" / "high Limit" (low Limit greater high Limit) does not result in an error. Such kind of configuration can be used, if the supervising range exceeds the "Total measuring range"

7.6.2 Global registers of the Cam Channel

View of the global registers assigned to one channel of 8 cams.

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Cam Ch. Reg.								
State / Enable / Polarity	_No_8	_No_7	_No_6	_No_5	_No_4	_No_3	_No_2	_No_1

7.6.2.1 Cam Channel State register

This attribute defines the status bit of the cam. The status bit set to "1" defines "*cam active*". The status bit set to "0" defines "*cam inactive*". If the CAM polarity register attribute of a cam is **set** (1) the actual cam state will be inverted.

State	Polarity bit = 0 (default)	Polarity bit = 1 (inverted)
Position within limits Position outside limits	"cam active" / [1] "cam inactive" / [0]	"cam active" / [0] "cam inactive" / [1]

7.6.2.2 Cam Channel Enable register

Attribute contains the calculation state for the respective cams. If the corresponding bit is set to "1", the cam state will be calculated. In the other case the cam state of the related cam will be set permanently to "0" (inactive).

7.6.2.3 Cam Channel Polarity register

Attribute contains the actual polarity settings for a maximum of 8 cams. If the polarity bit is set to "1", the cam state of an active cam will signal by setting the related cam state bit to zero. In the other case the cam state of the related cam will not be inverted. (see above).

7.6.3 Limit of switch points and hysteresis

The encoder supports one channel with 8 different cams. Each cam has parameters for:

- the Low and High Limit setting
- the delay setting (hysteresis) of the switch points

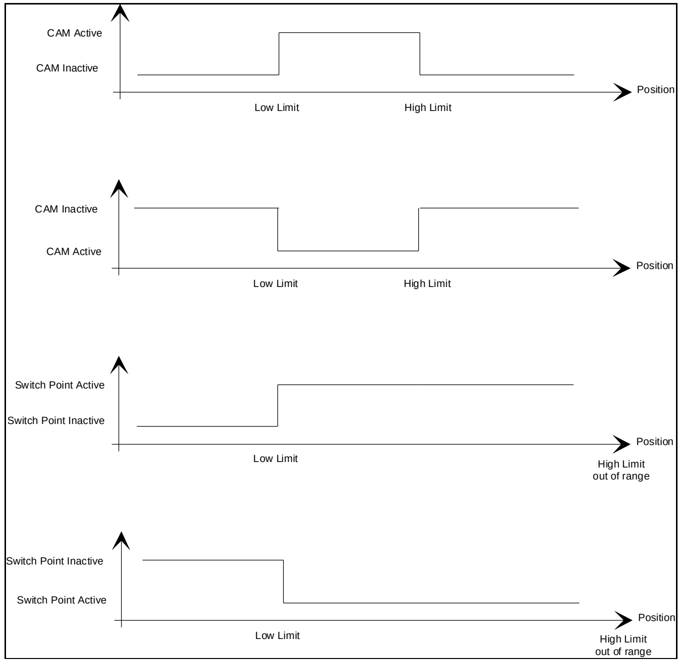


Figure 7–2: Usage of the switch points regarding the polarity

7.7 Encoder - Diagnostic Attributes

7.7.1 Operating Status

This attribute contains the operating status regarding the following encoder basic attributes:

Bit	Description		
		Value (0)	**Value (1)**
0	Direction counting (code sequence)	CW	CCW
1	Diagnostics control	OFF	ON
2	Scaling function control	OFF	ON

7.7.2 Physical Resolution Span (Single Turn Resolution) -- [PRS]

Absolute physical resolution in steps per span (revolution) the encoder is supporting.

Byte 3 (MsB)	Byte 2	Byte 1	Byte 0 (LsB)	
00	00	20	00	8192 - (13 bit)

7.7.3 Number of distinguishable revolutions -- [PnumRev]

Absolute physical revolutions the encoder is supporting. This value and the PRS value give the physical measuring range [PMR].

		Byte 1 (MsB)	Byte 0 (LsB)	
		20	00	8192 - (13 bit)

7.7.4 Alarm functionality

The "Alarm Flag" (Attr. 85) indicates if any of the "supported alarms" (Attr. 84) occurs. If a significant error condition occurs, the according bit in the "alarm message" (Attr. 83) is set to logical high, and the "Alarm Flag" is changed into "SET" (1) state.

The "Alarm Flag" is only changed into "RESET" (0) state, after the "alarm message" is cleared by a Read operation due to an Explicit message to this attribute. -- In addition the current situation must be in an error-free condition.

"Alarm Flag" is implemented as data component in assembly instance no. 2.

Table below shows the supported alarms regarding the "alarm message".

Bit	"Alarm Message"	Value (0)	Value (1)
0	Position Error	NO	YES
1 [x]	Diagnostic Error (encoder standstill)	NO	YES
2...11	Reserved	NO	YES
12	EEPROM / IIC-Bus error	NO	YES
13	EEPROM Checksum (CRC) error	NO	YES
14...15	Not used		

n [x] These functions are **not** supported by the ATM60-D.

7.7.5 Warning functionality

The "Warning Flag" (Attr. 88) indicates if any of the "supported warnings" (Attr. 87) occurs. If a less significant error condition occurs, the according bit in the "warning message" (Attr. 86) is set to logical high, and the " Warning Flag" is set into "SET" (1) state.

The " Warning Flag" is always set into "RESET" (0) state, after the "warning message" indicates an error-free condition. This way a warning remains not stored, if the corresponding error condition occurs only one time.

"Warning Flag" is implemented as data component in assembly instance no. 2.

Table below shows the supported warnings regarding the "warning message".

Bit	"Warning Message"	Value (0)	Value (1)
0	Frequency exceeded	NO	YES
1 [x]	Light control reserve	Not reached	Error
2	CPU watchdog	OK	Reset
3 [x]	Operating time limit warning	NO	YES
4 [x]	Battery charge	OK	Too Low
5 [x]	Reference Point	Reached	Not reached
6	Minimum Velocity Flag	OK	fall below
7	Maximum Velocity Flag	OK	exceed
8	Minimum Acceleration Flag	OK	fall below
9	Maximum Acceleration Flag	OK	exceed
10...12	Reserved		
13	Cam_xx limits (high, low) out of order	NO	YES
14...15	Not used		

n [x] These functions are **not** supported by the ATM60-D.

7.7.6 Profile and Software Version

The first 16 bits contains the profile version of the implemented encoder object. It is combined to a revision number and an index.

The second 16 bits contains the software version of the implemented encoder object. It is combined to a revision number and an index. The index indicates the internal software revision.

Byte 3 (MsB)	Byte 2	Byte 1	Byte 0 (LsB)
Software Version		Profile Version	
number	Index	number	index
04_{hex}	31_{hex}	01_{hex}	00_{hex}

7.7.7 Operating Time

This attribute shows the number of hours the encoder has been operating since the first putting into operation or since the last switch-on, depending on the 'Update Functionality' configured to the diagnostic values. (See 7.8.2).

The value is presented in units of [0.1 hours].

7.7.8 Offset Value

This attribute contains the parameter offset value. The offset value is calculated by the PRESET function and shifts the position value by the calculated value. The Offset Value is saved **automatically** to the EEPROM, after every operation, either by PRESET Button or by setting the PRESET Value via protocol.

7.7.9 Module Identification

The Minimum / Maximum Position Value are limit values, only changeable by manufacturer. The values are given in steps according to the basic resolution of the encoder.

Byte 3	Byte 2	Byte 1	Byte 0	Maximum position value (Attr. 93)
03	FF	FF	FF	67.108.863 8192

Byte 3	Byte 2	Byte 1	Byte 0	Minimum position value (Attr. 94)
00	00	00	00	0

0002	multiturn absolute rotary encoder	Encoder Type (Attr. 95)

7.8 Encoder - Manufacturer Functionality

Attr. ID	Attribute Name	Access Rule	Type	Description
100	Reserved			
101 (x)	Node Commis-sioning	Get / Set	BOOL	Assigning node address and data rate to device by Hardware (DIP-Switch) or Software.
102	Update special diagnostic data	Get	BOOL	Save the special diagnostic data to EEPROM (YES / NO).
103	Display special diagnostic data	Get	BOOL	Possibility to display the special diagnostic data (YES / NO)
104	Reserved			
105	Reserved			
106	Device Switches	Get	WORD	Indicates the state of the operating devices (S1-S4) within the bus connector housing.
107	Number of "Switch-On"	Get	UINT	Indicates the number the device has been switched on, since putting into operation.
108	Max. velocity	Get	UINT	Maximum velocity value occurred since first or last Switch-On.
109	Max. accelera-tion	Get	UINT	Maximum acceleration value occurred since first or last Switch-On.
110	Motion Time	Get	UDINT	Complete time the encoder is in rotation.
111	Input Assy_Poll	Get / Set	USINT	assembly instance for Polling mode
112	Input Assy_COS	Get / Set	USINT	assembly instance for COS / Cyclic
113	Input Assy_BIT	Get / Set	USINT	assembly instance for BIT Strobed mode

101 (x) Function is **not** supported in this version of the ATM 60. -- Set to **DIP-Switches**

7.8.1 Node (Device) Commissioning (Attr. 101)

This parameter is to define the mode of "Node / Device Commissioning". Node commissioning, is the process of assigning a node address (MAC ID) and a data rate (Baudrate) to a device. This parameter is used to overwrite the **hardware-based** node commissioning which is used as the **factory default** value. Set this parameter to "software-based node commissioning" means the hardware settings are overwritten, and node address and data rate are set to the corresponding values located in the EEPROM. An additional indication (LED, DIP-Switch) must be used to display this mode.

0	Hardware Setting (Default)	Node address / Data Rate alterable via DIP-Switches.
1	Software Setting (EEPROM)	Node address / Data Rate alterable via protocol.

7.8.2 Update diagnostic data (Attr. 102)

Attribute only can be changed by manufacturer.

> If attribute is set to a "YES", the special diagnostic data (Attr. 90, 108, 109, 110) are saved to EEPROM in cycles of 0.1 hours. Otherwise the diagnostic data are lost by the next switch-off, and only show the data informations sampled since the **last** switch-on.

7.8.3 Display diagnostic data (Attr. 103)

Attribute only can be changed by manufacturer.

> If attribute is set to a "YES", the special diagnostic data (Attr. 90, 108, 109, 110) are displayed by a configuration tool. Otherwise no access is possible.

7.8.4 Device Switches (Attr. 106)

Attribute shows the settings of the two DIP Switches (S1, S2) and the state of the PRESET-Button (S4).

Byte_1 (MsB)								Byte_0 (LsB)							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		MAC-ID (S1) [DIP]						PRE SET					Baud-Rate (S2) [DIP]		
		6	5	4	3	2	1						3	2	1

7.8.5 Special diagnostic data (Attr. 108, 109, 110)

The value of these attributes depend on the configuration of attribute 102 (Update function).

The highest velocity the encoder has sampled since the first putting into operation or since the last switch-on.

The highest acceleration the encoder has sampled since the first putting into operation or since the last switch-on.

Time indication [Sec] the encoder has been operating (only in **rotation**) since the first putting into operation or since the last switch-on.

7.8.6 Configuration of the Input Assembly data

The following illustration shows how to configure an I/O connection with an appropriate "INPUT Assembly". -- (RSNetWorx).

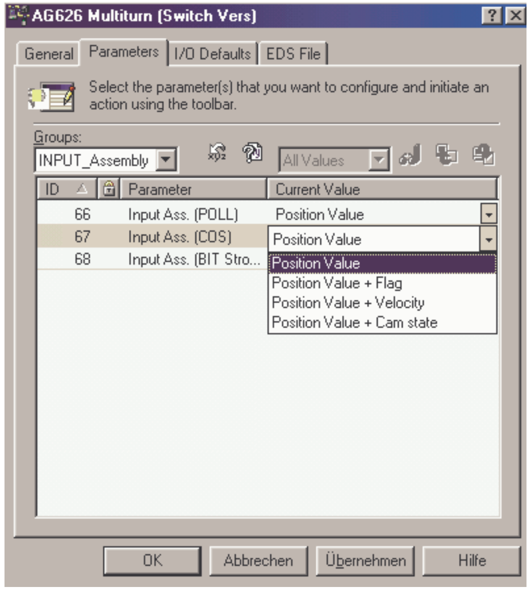


Figure 7–3: Setting Input Assembly data

Each of the 3 different I/O message connections is assigned its own attribute **"Input Assy_..".**

Each of these attributes can be assigned to different assemblies simultaneously (1...n).

By default each of the attribute is configured to assembly one (**1**) . -- "Position Value".

8 DeviceNet Messaging Protocol

To establish a connection, each DeviceNet product will implement either an Unconnected Message Manager (UCMM) or an Unconnected Port. Both perform their function by reserving some of the available CAN identifiers.

When either the UCMM or the Unconnected Port is used to establish an Explicit Messaging Connection, that connection is then used to move information from one node to the other, or to establish additional I/O connections. Once connections have been established, I/O data may be moved among devices on the network. At this point, all the protocol of the DeviceNet I/O message is contained within the 11-bit CAN identifier. Everything else is data.

When a connection is established, the transmissions associated with that connection are assigned a Connection ID (CID). If the connection involves a bi-directional exchange, then two connection ID values are assigned.

8.1 Use of the CAN Identifier

The 11-bit CAN identifier is used to define the Connection ID, partitioned into Group 1 to 4.

Identifier Bits											Identity Usage	Hex Range
10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**		
0	Message ID				Source MAC ID						Message Group 1	000 - 3FF
1	0	MAC ID						Message ID			Message Group 2	400 - 5FF
1	1	Message ID			Source MAC ID						Message Group 3	600 - 7BF
1	1	1	1	1	Message ID						Message Group 4	7C0 - 7EF
1	1	1	1	1	1	1	x	x	x	x	Invalid CAN Identifiers	7F0 - 7FF

Message ID	Identifies a message within a Message Group inside a particular end point. Group 2 and Group 3 predefine uses for certain Message IDs.
Source MAC ID	The MAC ID assigned to the transmitting node. Groups 1 and 3 require the specification of a Source MAC ID.
Destination MAC ID	The MAC ID assigned to the receiving device. Message Group2 allows the specification of either Source or Destination within the MAC ID portion.

8.2 Predefined Master / Slave Connection Set

To simplify the movement of I/O configuration-type data typically seen in a Master/ Slave architecture, a set of connection identifiers know as the "Predefined Master/ Slave Connection Set" has been specified. The Predefined Set contains one explicit messaging connection and allows several different I/O connections including:

- Bit Strobed Command/ Response
- Polled Command/ Response
- Change-of-State or Cyclic

The encoder ATM60-D are designed to perform some predetermined functions (provides input data / requires output data and configuration data).

The Predefined Master/ Slave Connection Set meets these needs by providing connection objects, that are almost entirely configured at the time the device powers up. A master device only have to claim ownership of this predefined connection set within its slave(s) to start the flow of data.

The 11 CAN Identifier Fields associated with the Predefined Master / Slave Connection Set are shown in the following figure:

Identifier Bits											Identity Usage	Hex Range
10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**		
0	**Message ID**				**Source MAC ID**						**Group 1 Messages**	**000-3FF**
0	1	1	0	1	Slave MAC ID						Slave's IO Change of State or Cyclic Message	
0	1	1	1	0	Slave MAC ID						Slave's IO Bit-Strobe Response Message	
0	1	1	1	1	Slave MAC ID						Slave's Poll Response or COS / Cyclic Ack	
1	**0**	**MAC ID**						**Mess. ID**			**Group 2 Messages**	**400-5FF**
1	0	Master MAC ID						0	0	0	Master's IO Bit-Strobe Command Message	
1	0							0	0	1	Reserved for Master's Use – Use is TBD	
1	0	Slave MAC ID						0	1	0	Master's COS or Cyclic Acknowledge Message	
1	0	Slave MAC ID						0	1	1	Slave's Explicit/Unconnected Response Message	
1	0	Slave MAC ID						1	0	0	Master's Explicit Request Message	
1	0	Slave MAC ID						1	0	1	Master's IO Poll Command or COS / Cyclic Message	
1	0	Slave MAC ID						1	1	0	Group 2 Only Unconnected Explicit Request Messages (reserved)	
1	0	Slave MAC ID						1	1	1	Duplicate MAC ID Check Message	

Mapping a data value existing of more than one Byte, to the DeviceNet protocol is performed in format "Little Endian".

The following designation applies to all examples below.

Identifier (bit 10...0)			Request to slave				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	000	01							

MAC ID [**3F**] $_{hex}$: Destination (Slave) -- Exception with MSG ID = 0
MSG ID { 0, 2, 4, 5, 6 7 }
Head contains the Source MAC-ID (Master): -- [**01**]

Identifier (bit 10...0)			Response Group-2				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011								

MAC ID [**3F**] $_{hex}$: Source (Slave)
MSG ID { 3, 7 }
Head contains the Destination MAC-ID (Master): -- [**01**]

8.3 Connecting to a Group 2 only Server

Every connection is implemented via "Group 2 only unconnected Explicit Messaging" (Group 2 Message-ID 6). In the Predefined Master/ Slave Connection Set an instance is created via the **Allocate_Master / Slave_Connection Set** (4Bhex) service of the DeviceNet object. This service receives the selected connection mode information via the Allocation Choice Byte.

Allocation Choice Byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Ack Suppress	Cycle	Change of State	Reserved	Bit Strobed	Polled	Explicit Message

8.3.1 Allocate_Master / Slave_Connection Set

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	110	01	4B	03	01	03	01		

MAC ID [3F]: Destination (Slave)
MSG ID [06]: Group 2 Only Unconnected Explicit Request Messages
Head Frag = 0, XID = 0, Source MAC-ID (Master)
Service Request "Allocate_Master / Slave_Connection Set"
Class Device Net Object
Instance Instance ID of Class
Data 0 Allocation Choice Byte
Data 1 Allocater's MAC-ID

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	CB	00					

MAC ID [3F]: Source (Slave)
MSG ID [03]: Slave's Explicit/ Unconnected Response Message
Head Frag = 0, XID = 0, Destination MAC-ID (Master)
Service Response to requested message
Data_0 Message Body Format (8 / 8)

In this example two message connections are allocated (Explicit and Polled).

The explicit message connection is automatically set to the "Established" state using the default Expected_Packet_Rate [10 sec]. After this time, the connection will be released, if no further access to the connection is done. The IO message connection is now in the "Configuring" state.

8.3.2 Set connection into "Established State"

To transfer an allocated IO connection into the state "Established", a previous allocated explicit message connection is used to set the attribute "Expected_Packet_Rate" for the IO connection. The following example is done for the Poll connection.

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	100	01	10	05	02	09	E8	03	

MSG ID	[04]: Master's Explicit Request Message
Head	Frag = 0, XID = 0, Source MAC-ID (Master)
Service	Request "Set_Attribute_Single"
Class	Connection Object
Instance	Instance ID of Class
Data 0	Attribute ID = Expected_Packet_Rate
Data 1 | 2	Time in ms (Low Byte) | (High Byte)

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	90	E8	03				

MSG ID	[03]: Slave's Explicit/ Unconnected Response Message
Head	Frag = 0, XID = 0, Destination MAC-ID (Master)
Service	Response to requested message
Data 0 | 1	Actual time in ms (Low Byte) | (High Byte) -- (possible adjusted)

8.3.3 Release Connection from Group 2 only Server

To release one ore more connections the service **Release_Master/ Slave_Connection Set** is used. The Release Choice Byte indicates which connections are to be released.

The following command releases the same two connections allocated in the above example.

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	110	01	4C	03	01	03			

MSG ID	[06]: Group 2 Only Unconnected Explicit Request Messages
Head	Frag = 0, XID = 0, Source MAC-ID (Master)
Service	Release "Allocate_Master / Slave_Connection Set"
Class	Device Net Object
Instance	Instance ID of Class
Data 0	Release Choice Byte

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	CC						

MSG ID	[03]: Slave's Explicit/ Unconnected Response Message
Head	Frag = 0, XID = 0, Destination MAC-ID (Master)
Service	Response to requested message

8.4 Non-Fragmented Explicit Messaging

Non-Fragmented means, the length of a message is less or equal 8 bytes and sent within one frame. A non-fragmented request message contains a header of 5 bytes (Head, Service, Class, Instance and Attribute). This means the real data length for a "Set" service is limited to 3 bytes.

8.4.1 Set attribute [Direction counting]

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	100	01	10	2F	01	03	01		

MSG ID	[04]: Master's Explicit Request Message
Head	Frag = 0, XID = 0, Source MAC-ID = 1
Service	Request "Set_Attribute_Single"
Class	Encoder Object
Instance	Instance ID of Class
Data 0	Attribute ID
Data 1	Value for the this attribute {0, 1}

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	90						

MSG ID	[03]: Slave's Explicit/ Unconnected Response Message
Head	Frag = 0, XID = 0, Destination MAC-ID (Master)
Service	Response to requested message

8.4.2 Get attribute [Operating Status]

A response message to the request uses two bytes as header information. This means, the real data length for a "Get" service is limited to 6 bytes.

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	100	01	0E	2F	01	50			

MSG ID	[04]: Master's Explicit Request Message
Head	Frag = 0, XID = 0, Source MAC-ID (Master)
Service	Request "Get_Attribute_Single"
Class	Encoder Object
Instance	Instance ID of Class
Data 0	Attribute ID = operating status

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
01	111111	011	01	8E	04					

MSG ID	[03]: Slave's Explicit/ Unconnected Response Message
Head	Frag = 0, XID = 0, Destination MAC-ID (Master)
Service	Response to requested message
Data 0	Current value of this attribute

8.4.3 Saving encoder parameters to EEPROM

Service **"Save"** of the object "Encoder" saves all parameters into the EEPROM. The service **"Reset"** and **"Restore"** are used in the same way to get the factory default values or the storage values from EEPROM. -- (No attribute ID is used)

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	100	01	16	2F	01				

MSG ID [04]: Master's Explicit Request Message
Head Frag = 0, XID = 0, Source MAC-ID (Master)
Service Request "Save"
Class Encoder Object

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	96						

MSG ID [03]: Slave's Explicit/ Unconnected Response Message
Head Fray = 0, XID = 0, Destination MAC-ID (Master)
Service Response to requested message

8.5 Fragmented Explicit Messaging

Fragmented means, the length of a message is greater 8 bytes and must sent within more frames. A fragmented request message contains within its first frame a header of 6 bytes (Head, Frag, Service, Class, Instance and Attribute). All other frames contain a header of 2 bytes (Head, Frag).

Fragmentation is used in the following cases:

Service	
Get attribute	Real data length > 6 Bytes
Set attribute	Real data length > 3 Bytes

8.5.1 Set attribute [Preset Value]

This command request message set the "Preset Value" (4 Byte) to $[01.02.03.04]_{hex}$.

Identifier (bit 10...0)			Data (8 Byte)				(Fragment 1) →			
Gr	MAC ID	MSG ID	Head	Frag	Service	Class	Instance	Data 0	Data 1	Data 2
10	111111	100	81	00	10	2F	01	0A	04	03

MSG ID [04]: Master's Explicit Request Message
Head Frag-Bit = 1, XID-Bit = 0, Source MAC-ID (Master)
Frag [ttnn-nnnn] with tt = fragment type [First], nn-nnnn = fragment number [0]
Service Request "Set_Attribute_Single"
Class Encoder Object
Instance Instance ID of Class
Data 0 Attribute ID
Data 1 | 2 | Value for the selected attribute {Bit 07...00} | {Bit 15...08}

Identifier (bit 10...0)			Data (8 Byte)				(Ack 1) ←			
Gr	MAC ID	MSG ID	Head	Frag	Rsp_0	Rsp_1	Rsp_2	Rsp_3	Rsp_4	Rsp_5
10	111111	011	81	C0	00					

MSG ID [03]: Slave's Explicit/ Unconnected Response Message
Head Frag-Bit = 1, XID-Bit = 0, Destination MAC-ID (Master)
Frag [ttnn-nnnn] with tt = fragment type [Response], nn-nnnn = fragment number [0]
Rsp_0 Status (Success)

Identifier (bit 10...0)			Data (8 Byte)				(Fragment 2) →			
Gr	MAC ID	MSG ID	Head	Frag	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5
10	111111	100	81	81	02	01				

Head Frag-Bit = 1, XID-Bit = 0, Source MAC-ID (Master)
Frag [ttnn-nnnn] with tt = fragment type [Last], nn-nnnn = fragment number [1]
Data 0 | 1 | Value for the selected attribute {Bit 23...16} | {Bit 31...24}

Identifier (bit 10...0)			Data (8 Byte)				(Ack 2) ←			
Gr	MAC ID	MSG ID	Head	Frag	Rsp_0	Rsp_1	Rsp_2	Rsp_3	Rsp_4	Rsp_5
10	111111	011	81	C1	00					

Head Frag-Bit = 1, XID-Bit = 0, Destination MAC-ID (Master)
Frag [ttnn-nnnn] with tt = fragment type [Response], nn-nnnn = fragment number [1]
Rsp_0 Status (Success)

Additionally confirmation of the complete Sequence (as non-fragmented sequence)

Identifier (bit 10...0)			Data (8 Byte)				(Ack 3) ←			
Gr	MAC ID	MSG ID	Head	Service	Data_0	Data_1	Data_2	Data_3	Data_4	Data_6
10	111111	011	01	90						

8.5.2 Get attribute [Array of supported attributes]

The example shows how to get a data array containing the numbers of all the supported attributes of an object.

This command request message causes a fragmented response from the slave.

Identifier (bit 10...0)			Data (8 Byte)				(Request) →			
Gr	MAC ID	MSG ID	Head	Service	Class	Instance	Data 0	Data 1	Data 2	Data 3
10	111111	100	01	0E	2F	01	02			

MSG ID [04]: Master's Explicit Request Message
Head Frag = 0, XID = 0, Source MAC-ID (Master)
Service Request "Get_Attribute_Single"
Class Encoder Object
Instance Instance ID of Class
Data 0 Attribute ID

Identifier (bit 10...0)			Data (8 Byte)				(Fragment 1) ←			
Gr	MAC ID	MSG ID	Head	Frag	Ser-vice	Rsp_0	Rsp_1	Rsp_2	Rsp_3	Rsp_4
10	111111	011	81	00	8E	01	02	03	04	05

MSG ID	[03]: Slave's Explicit/ Unconnected Response Message
Head	Frag-Bit = 1, XID-Bit = 0, Destination MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [First], nn-nnnn = fragment number [0]
Service	Response to requested message
Rsp_0 4	Response Data (Byte 1...5)

Identifier (bit 10...0)			Data (8 Byte)				(Ack 1) →			
Gr	MAC ID	MSG ID	Head	Frag	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5
10	111111	100	81	C0	00					

Head	Frag = 1, XID = 0, Source MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [Ack], nn-nnnn = fragment number [0]
Data 0	Status (Success)

Identifier (bit 10...0)			Data (8 Byte)				(Fragment 2) ←			
Gr	MAC ID	MSG ID	Head	Frag	Rsp_0	Rsp_1	Rsp_2	Rsp_3	Rsp_4	Rsp_5
10	111111	011	81	41	**06**	**07**	**08**	**09**	**0A**	**0B**

Head	Frag-Bit = 1, XID-Bit = 0, Destination MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [Middle], nn-nnnn = fragment number [1]
Rsp_0 5	Response Data (Byte 1...6)

Identifier (bit 10...0)			Data (8 Byte)				(Ack 2) →			
Gr	MAC ID	MSG ID	Head	Frag	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5
10	111111	100	81	C1	00					

Head	Frag = 1, XID = 0, Source MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [Ack], nn-nnnn = fragment number [1]
Data 0	Status (Success)

Identifier (bit 10...0)			Data (8 Byte)				(Fragment 3) ←			
Gr	MAC ID	MSG ID	Head	Frag	Rsp_0	Rsp_1	Rsp_2	Rsp_3	Rsp_4	Rsp_5
10	111111	011	81	82	**0C**	**0D**	**0E**	**0F**	**10**	**11**

Head	Frag-Bit = 1, XID-Bit = 0, Destination MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [Final], nn-nnnn = fragment number [2]
Rsp_0 5	Response Data (Byte 1...6)

Identifier (bit 10...0)			Data (8 Byte)				(Ack 2) →			
Gr	MAC ID	MSG ID	Head	Frag	Data 0	Data 1	Data 2	Data 3	Data 4	Data 5
10	111111	100	81	C2	00					

Head	Frag = 1, XID = 0, Source MAC-ID (Master)
Frag	[ttnn-nnnn] with tt = fragment type [Ack], nn-nnnn = fragment number [2]
Data 0	Status (Success)

8.6 IO Messaging

For using the IO messaging you have to allocate an IO connection specified in the allocation choice Byte as done in the first example (see 8.3), and the connection set into the "Established State".

8.6.1 Poll command request/ response message

The configured assembly instance (Input Data) determines the data component(s) sent as the response to the Poll request.

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Data 0	Data 1	Data2	Data 3	Data 4	Data 5	Data 6	Data 7
10	111111	101								

MAC ID	[3F]: Destination (Slave)
MSG ID	[05]: Master's I/O Poll Command / COS Message
Data	None

Identifier (bit 10...0)			Data (8 Byte)				←			
G	MSG ID	MAC ID	Data 0	Data 1	Data2	Data 3	Data 4	Data 5	Data 6	Data 7
0	1111	111111	01	1F	01	00				

MAC ID	[3F]: Source (Slave)
MSG ID	[0F]: Slave's Poll Response or COS Message (Group 1)
Data 0 | 1 | 2 | 3 |	Position value Bit 07 -- 00 | 15 -- 08 | 23 -- 16 | 31 -- 24 |

8.6.2 Bit Strobed command request/ response message

The configured assembly instance (Input Data) determines the data component(s) sent as the response to the Bit Strobed request. -- **Note**: MAC ID shows the Master address.

Identifier (bit 10...0)			Data (8 Byte)				→			
Gr	MAC ID	MSG ID	Data 0	Data 1	Data2	Data 3	Data 4	Data 5	Data 6	Data 7
10	000001	000								

MAC ID	[01]: Source (**Master**)
MSG ID	[00]: Master's I/O Bit-Strobe Command Message
Data 0...7	optional (No data, or all 8 Byte used)

Identifier (bit 10...0)			Data (8 Byte)				←			
G	MSG ID	MAC ID	Data 0	Data 1	Data2	Data 3	Data 4	Data 5	Data 6	Data 7
0	1110	111111	01	1F	01	00				

MAC ID	[3F]: Source (Slave)
MSG ID	[0E]: Slave's Bit Strobed Response Message (Group 1)
Data 0 | 1 | 2 | 3 |	Position value Bit 07 -- 00 | 15 -- 08 | 23 -- 16 | 31 -- 24 |

9 Commissioning of the Encoder

9.1 Node Commissioning

Node Commissioning is required for every device prior to gaining access to a DeviceNet network. This means that a node address and a data rate must be programmed into the device. The factory default settings are set according the DeviceNet specification using DIP switches.

> The ATM60-D only supports a hardware-based node commissioning.

Change the factory settings for node address and data rate according to your network specification, by using the corresponding DIP-Switches. -- See 10.4 (Operating devices).

9.2 Configuration of the Encoder using RSNetWorx

Configuring parameters of a device can be achieved by a configuration tool in conjunction with an Electronic Data Sheet (**EDS**). Parameters can be edited in point-to-point or over a network.

A configuration tool (EDS interpreter) like RSNetWorx for DeviceNet must support the following:

- Reading and interpreting any standard EDS.
- Presenting information and choices to the device users.
- Apply the changes to device.

You can use the RSNetWorx for DeviceNet software to customize your DeviceNet configuration. To get access to the encoder, it must be in state *On-Line*. The commissioning of a DeviceNet system may be done in different ways.

- **Off-line mode**: The parameters for the bus participants are set without an established connection to the bus network. The values showed are taken from the EDS file
- **On-line mode**: The parameters for the bus participants are configured using an established bus connection to the bus network. Thereafter the bus connection is made and the user data are transferred to the master as well as to the bus participants.

9.2.1 Installation of the EDS file

The EDS file, which is shipped with the encoder, must be installed with the RSNetWorx. Go to ***Tools - EDS Wizard..*** and following the wizard to install the file "AG_626_x.eds".

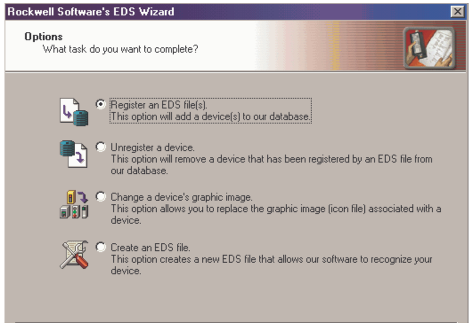


Figure 9–1: EDS Wizard

Assign the supplied bitmap file **"AG_626.ico"** to the encoder.

Installation of the EDS file and the corresponding icon is now completed.

9.2.2 Offline integration into the Network

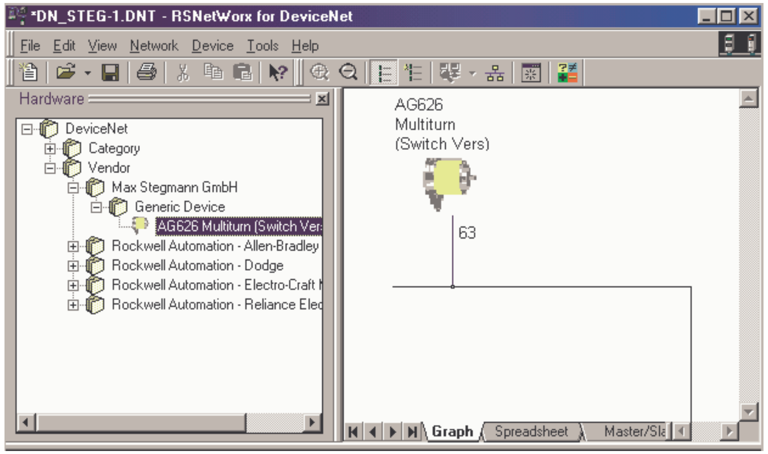


Figure 9–2: Hardware Window

After the project is started select the ATM60-D encoder under the “Vendor” category in the hardware window. Click on it, then add the encoder with drag and drop into the network.

To assign a name, description and node address double-click on the device in the Graph view window. Please enter the node address that has been set via the 6 pole DIP switches.

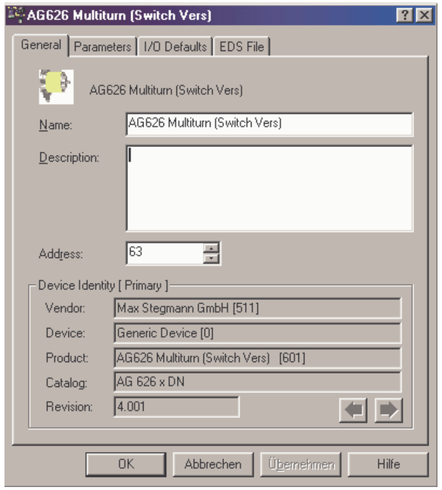


Figure 9–3: General Properties

9.2.3 Setting encoder parameters

In order to modify the parameter values of the encoder on DeviceNet, RSNetWorx offers two configuration modes:

- Enhanced Device Configuration
- Class Instance Editor

The Enhanced Device Configuration is a more comfortable way to read and modify encoder parameters. This mode can be used online and off-line (file access only). In the Enhanced Device Configuration mode the parameters can be stored to a file (*.dnt) for later transfer to the device.

9.2.4 Enhanced Device Configuration in off-line mode

The Enhanced Device Configuration is started by double-clicking on the encoder symbol. In off-line mode the parameters are presented with the default defined in the EDS file.

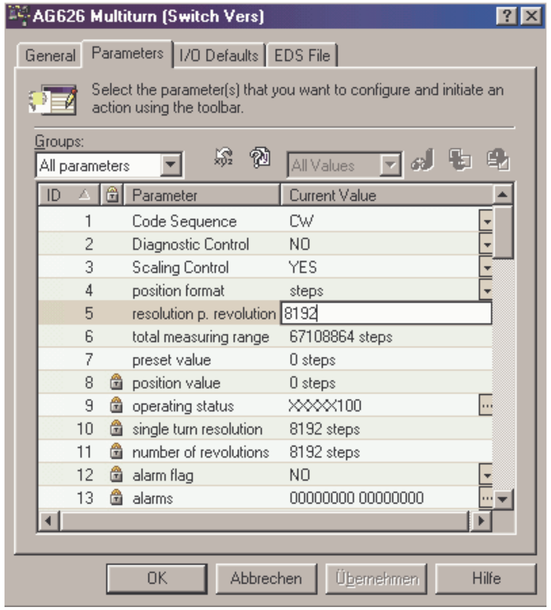


Figure 9–4: Setting Parameters

Parameters that are labeled " “ represent status information of the encoder and only available for read access. All other data can be modified. Parameter values can be modified by double-clicking on the selected parameter. After all parameters are set they can be stored in a file using the File – Save command.

9.2.5 Enhanced Device Configuration in on-line mode

The Enhanced Device Configuration is selected by double-clicking on the encoder symbol. In online mode the parameter values currently stored in the encoder are accessed.

By clicking on the "***Apply or Download to Device***" buttons the parameters can be saved to the encoder. The updated encoder values are stored in the encoder RAM and are valid immediately. Saving the new parameter values to the EEPROM is done with a separate command.

9.2.6 Using Class Instance Editor to access EEPROM data

Select the device in the graph window, click on "***Class Instance Editor..***" in the "***Device***" menu. Select the following:

- Service Code
- Class ID (use number of object "Encoder" $[2F]_{hex}$
- Instance ID of this object

Finish by clicking on the "***Execute***" button.

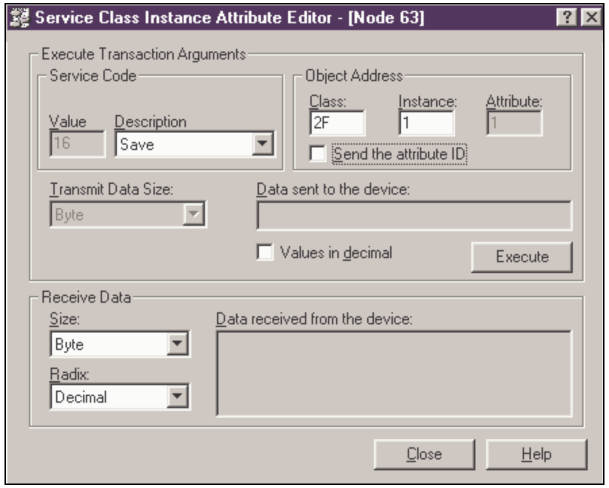


Figure 9–5: Class Instance Editor

The following services "Save", "Reset", and "Restore" can only be executed in on-line mode using the Class Instance Editor.

Save	(16_{hex})	All parameters are stored in the encoder EEPROM. -- Use this service to protect parameter values against loss due power failure.
Restore	(15_{hex})	All parameters are set to the values stored in the EEPROM
Reset	(05_{hex})	All parameters are set to the manufacturer default values

10 Installation

10.1 Mechanical Installation

Do not rigidly connect the encoder shaft to the machine. This will cause a failure in either the bearings of the encoder or the bearings of the machine shaft. Always use a flexible coupling.

10.1.1 Couplings

- Be sure to select the proper size flexible coupling clamp to mate to the encoder shaft.
- To prevent coupling damage the coupling must no be operated in a state of excessive axial compression or extension. Be sure the shafts fit freely in the coupling bores and that the coupling is not compressed or subjected to greater deflections than specified.

10.1.2 Encoders with servo flange

In this flange design, there are the following installation options:

- Via the 3 threaded holes on the flange side (Figure 10–1)
- With servo clamps on the servo groove (Figure 10–2)

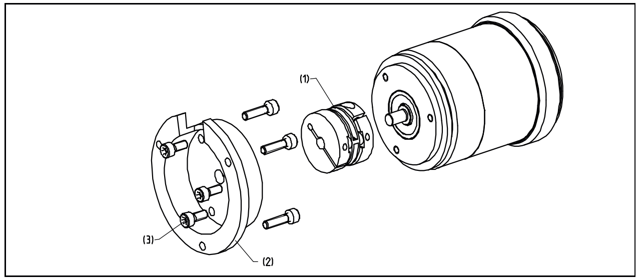


Figure 10–1: Servo flange (Installation via threaded holes)

- ♦ Lock the drive shaft on the application side.
- ♦ Mount the coupling (1) on the encoder. Take care that it does not touch the encoder flange.
- ♦ Push the encoder, with mounted coupling (1), onto drive shaft and mounting spigot into centring recess (2).
- ♦ Fix the encoder with 3 M4 screws (3).
- ♦ Fix the coupling (1) to the drive shaft. -- The coupling must not be subjected to any axial stresses.

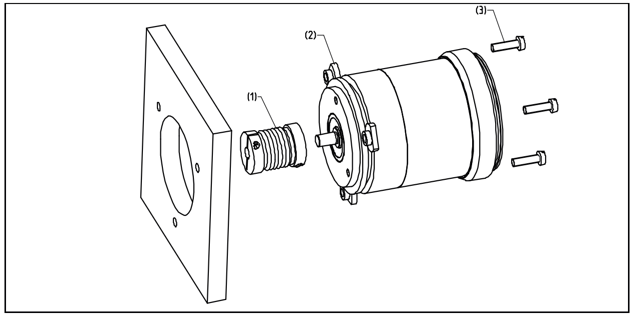


Figure 10–2: Servo flange (Installation with servo clamps)

- ♦ Lock the drive shaft on the application side.
- ♦ Mount the coupling (1) on the encoder. Take care that it does not touch the encoder flange.
- ♦ Mount the servo clamps (2) with M4 screws (3).
- ♦ Do not tighten screws, rotate the servo clamps so that the encoder flange can be pushed into the centring recess.
- ♦ Push the encoder, with mounted coupling (1), onto drive shaft and centring recess.
- ♦ Push the servo clamps (2) into the groove by rotating them and tighten slightly.
- ♦ Fix the coupling (1) to the drive shaft. -- The coupling must not be subjected to any axial stresses.
- ♦ Tighten all 3 screws on the servo clamps.

10.1.3 Encoders with face mount (clamping) flange

In this flange design, there are the following installation options:

- Via the 3 threaded holes on the flange side (Figure 10–3).
- by clamping the mounting spigot (Figure 10–4).

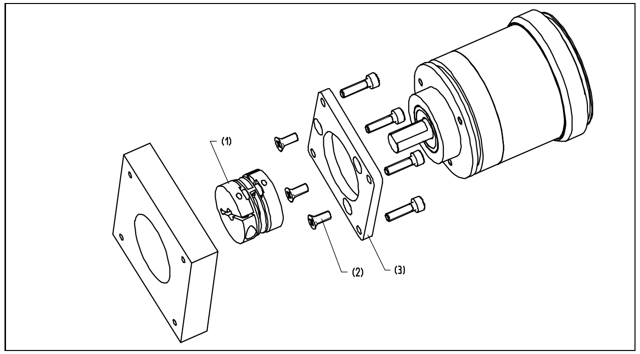


Figure 10–3: Face mount flange (Installation via threaded holes)

- ♦ Lock the drive shaft on the application side.
- ♦ Mount the coupling (1) on the encoder. Take care that it does not touch the encoder flange.

- ♦ Push the encoder with, mounted coupling (1), onto drive shaft and centring recess (3).
- ♦ Fix the encoder with 3 M4 screws (2).
- ♦ Fix the coupling (1) to the drive shaft. -- The coupling must not be subjected to any axial stresses.

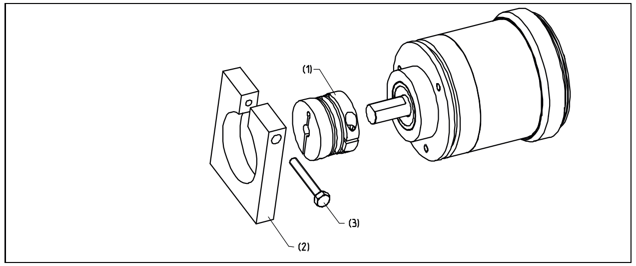


Figure 10–4: Face mount flange (Installation via mounting spigot)

> Since the mounting spigot is also the means of centring, the clamping device must be constructed in such a way that when it is clamped firmly, no impermissible angular or shaft offset results.

- ♦ Lock the drive shaft on the application side.
- ♦ Mount the coupling (1) on the encoder. Take care that it does not touch the encoder flange.
- ♦ Fit the encoder with, mounted coupling (1), onto drive shaft, and the mounting spigot into the clamping device (2).
- ♦ Clamp the encoder firmly with the screw (3).
- ♦ Fix the coupling (1) to the drive shaft. -- The coupling must not be subjected to any axial stresses.

10.1.4 Encoders with stator coupling for blind hollow shaft

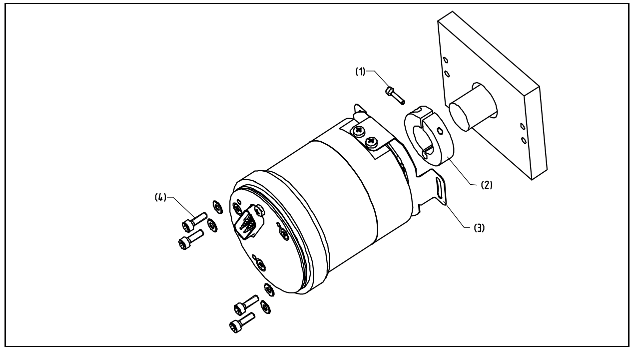


Figure 10–5: Blind Hollow shaft

- ♦ Lock the drive shaft on the application side.
- ♦ Loosen the socket-head screw (1) on the clamping ring (2).

- ♦ Push the encoder and collet onto the drive shaft. -- Take note of installation (Figure 10–6).
- ♦ Fix the torque support (3) with 4 M3 screws (4) and washers.
- ♦ Firmly tighten the socket-head screw (1) on the clamping ring (2).

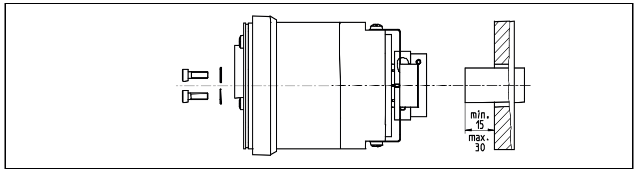


Figure 10–6: Note of Installation

10.2 Guidelines for Cable System

In an interference-free environment unshielded cable is permitted. The following reasons advises the use of shielded cable in every case:

- An interference-free space exists at most in the interior of shielded switch cabinets. However, as soon as there are also relays in the cabinet, freedom from interference is no longer ensured.
- The use of shielded cable demands additional protective measures against over-voltages at the bus signal inputs.

You must ground your DeviceNet cable system at only **one** location, preferably near the physical centre of the network using a PowerTap tap.

Do not connect the grounding terminals of additional PowerTap taps, additional power supplies or additional devices to an earth ground.

For non-isolated physical layer device, make sure that additional grounding does not occur due to mounting of the device or external connections to the device.

Follow the instructions to connect the network cable system to a Bus Connector with cable termination regarding the preparation.

10.3 Electrical Connection

Make the electrical connections with the voltage switched OFF. -- After installation switch ON the voltage and check the functioning of the encoder.

Only a **thin** cable (specified by an outside diameter of 6.9mm) can be used to connect the encoder to the network. This is due by the dimension of the cable gland or the connector.

To connect the ATM60-D to a DeviceNet network, a DeviceNet (bus terminal housing) is used with the following options:

- AD-ATM60-KR1DN resp. AD-ATM60-KR2DN (cable termination) with one or two gland(s).
- AD-ATM60-SR1DN resp. AD-ATM60-SR2DN (connector termination) with one or two circular plug-in connector(s).

Both designs are available with either one or two port(s).

10.3.1 DeviceNet adaptor with one port (AD-ATM60-?R1DN)

This type of bus connector contains only one port named IN/US (plug-in connector or cable gland). The connection to the cable system can only be done by drop line. No bus termination is used (both sliders OFF).

10.3.2 DeviceNet adaptor with two ports (AD-ATM60-?R2DN)

This type of bus connector contains two ports (plug-in connectors or cable glands). The connection to the cable system can be done directly to the trunk line as well as to the drop line.

A connection to the trunk line is called a "zero-length" drop or "daisy chain" configuration, and means, you have to attach the incoming bus cable to port "IN/US", and the outgoing bus cable to port "OUT/US". -- To use the bus termination see section 10.4.3.

- Take care, that the max. current flow to the terminal strip (pin 3/8 and 2/9) on the PCB does not exceed the value of 2 A.
- The max. number of Encoders in series connection is limited to **8**.

10.3.3 DeviceNet adaptor with cable termination (AD-ATM60-KR?DN)

This design has one or two screw fitting(s) / cable gland(s) in the style PG-9. Gland nuts secure cables to the bus connector enclosure. To attach the device to the network:

Prepare the ends of the cable section.

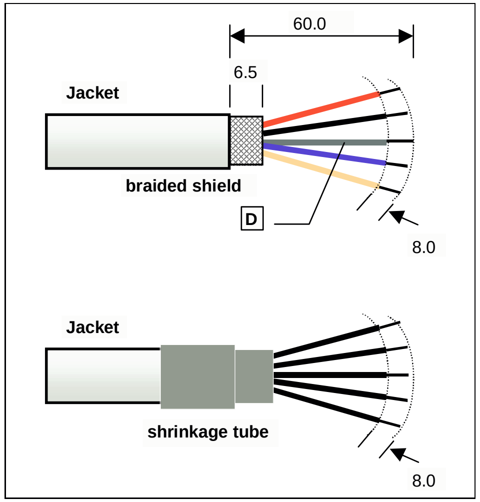


Figure 10–7: Preparation of cable

- ♦ Strip approx. 60 mm of the outer jacket and braided shield from the end of the cable, leaving no more than 6.5mm of the braided shield exposed.
- ♦ Cut the foil shields surrounding the power and signal conductors.
- ♦ Firmly twist the braided shield and the drain wire (D). Use insulating tubing on this wire.

- Use shrinkage tube (shrink wrap), covering part of the exposed conductors and part of the jacket.
- Strip approx. 8 mm of insulation from the ends of all the insulated conductors except the bare drain wire. Firmly twist the bare wire ends to eliminate loose strands. Fasten wire-end sleeves to all conductors.

Attach the cable to the enclosure:

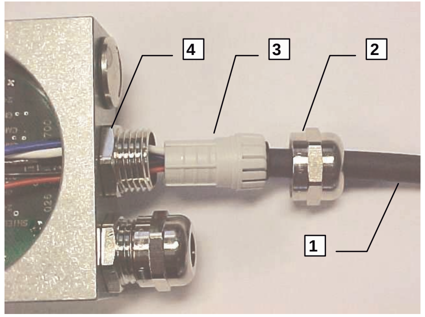


Figure 10–8: Cable termination

- Loosen the large gland nut (2).
- Insert the canned cable (1) through the gland nut (2), sealing body (3) and cable gland (4) so that about 3 mm of the cable jacket extend beyond the inside of the enclosure.
- Firmly tighten the gland nut to provide strain relief and sealing. Do not twist or pull the cable while tightening the gland nut.
- **Note**: Hold the hex flange (4) in place during tightening.

Make the attachments inside the enclosure. Insert conductors into the terminal block (strip) clamping cavities according Figure 10–11, and tighten all clamping screws to secure the conductors to the terminal block. Figure below shows the attachment (pin-1, pin-6...9) to an enclosure with one port (Input). The conductors of a second port (Output) are attached to the other clamping cavities (pin-1...5)

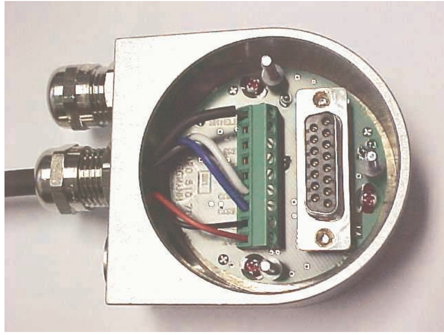


Figure 10–9: Cable attachment using one port

Assemble the Bus Connector and encoder. -- See Figure 10–12: Assembly of Bus Connector and encoder.

10.3.4 DeviceNet adaptor with circular plug-in connectors (AD-ATM60-SR?DN)

This design has one / two circular plug-in connector(s) in the micro-style. Use cables with attached 5 pin QD connectors to attach the device to the network. This saves you the effort of stripping and wiring connectors to the cable ends.

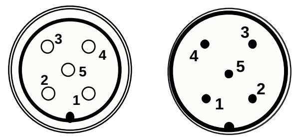
OUT/ US (socket) IN/ US (pin)		Function	Description
	1	Shield	Drain / Shield
	2	24V / (U_S)	Supply voltage (10V--32V)
	3	GND (COM)	0 V (Gnd)
	4	CAN_H	CAN Bus signal high
	5	CAN_L	CAN Bus signal low

Figure 10–10: Plug-in connectors

10.3.5 Terminal strip inside DeviceNet adaptor

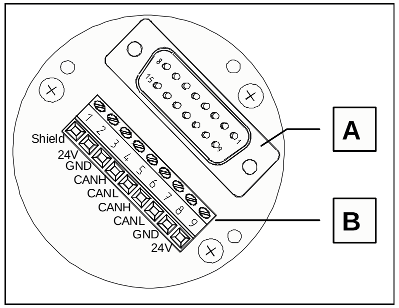


Figure 10–11: Pin allocation

A 15-pin Sub D plug connector to put on the encoder.
B Terminal strip with clamping cavity to attach network wiring.

Terminal Number	Function	Description
1	Shield	Shield (Drain)
2	24V / (U_S)	V+ (Supply voltage 10V -- 32V) / 24VDC recommend.
3	GND (COM)	V- (Gnd)
4	CAN_H	CAN Bus signal high
5	CAN_L	CAN Bus signal low
6	CAN_H	CAN Bus signal high
7	CAN_L	CAN Bus signal low
8	GND (COM)	V- (Gnd)
9	24V / (U_S)	V+ (Supply voltage 10V -- 32V) / 24VDC recommend.

10.3.6 Assembly of DeviceNet adaptor and ATM60-D encoder

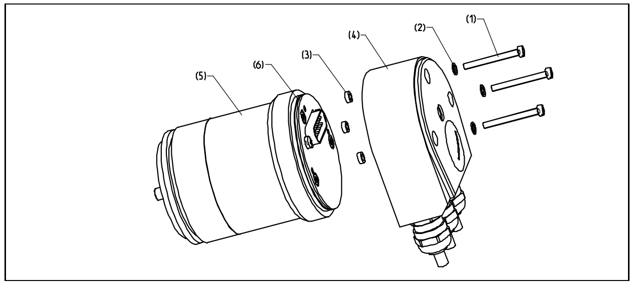


Figure 10–12: Assembly of Bus Connector and encoder

- Put the encoder (5) onto the bus connector housing (4). Take care of the correct adjustment and placement of the O-ring seal (6).

- Fix the bus connector housing with washers (2) and 3 M3 screws (1). -- (Socket-head / cross-recessed). Firmly tighten the screws to gain a good protection.

10.4 Operating Devices

Some characteristics of the ATM60-D may be configured by means of hardware settings. These are NODE Address, Data Rate, Electronic adjustment, and Bus termination.

In order to execute one of these functions, remove the screw cover from the back of the bus connector housing. Inside three DIP switches and a push-button become visible.

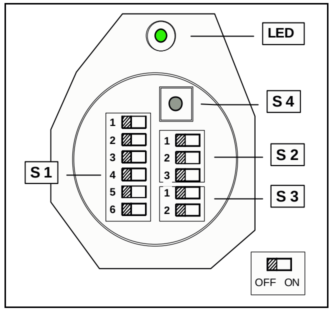


Figure 10–13: Operating devices

S 1 Address setting (Node ID)
S 2 Baud Rate setting (Data Rate)
S 3 Bus Termination
S 4 Electronic adjustment (number SET)

Connecting this product to an operational DeviceNet network with improperly set DIP switches, usually will cause the entire network to stop communicating.

10.4.1 MAC ID Switch

The NODE Address (MAC-ID) can be set with DIP switch S1. The factory default setting is 63. The address must be different than the rest of the network.

DIP-6	DIP-5	DIP-4	DIP-3	DIP-2	DIP-1	Node ID
2^5	2^4	2^3	2^2	2^1	2^0	
0	0	0	0	0	0	0
0	0	0	0	0	1	1
...	...	...	...	...	...	...
1	1	1	1	1	1	63

10.4.2 Baud Rate Switch

The transmission Data Rate (Baud Rate) can be set with DIP switch S2. The factory default setting is 125 Kbaud. -- Baud rate setting must be the same as the rest of the network.

DIP-3	DIP-2	DIP-1	Data Rate
X	0	0	125 Kbaud
X	0	1	250 Kbaud
X	1	0	500 Kbaud
X	1	1	125 Kbaud

X = don't care	0 = DIP switch is OFF	1 = DIP switch is ON

10.4.3 Bus Termination

The Bus termination can be set with DIP switch S3. The factory default setting is "OFF".

Each end of the CAN bus (trunk line) must be terminated with a resistor (120 Ohm) between the signals CAN_H and CAN_L !

The recommended method for connecting DeviceNet products is to run a "trunk line" with 120 ohm resistors connected at each end. DeviceNet products are connected as "drops" along the length of the trunk line. In this configuration, the internal termination resistor of the encoder should not be used, and the bus termination DIP switches should be OFF.

When the ATM60-D encoder is connected in a "daisy chain" configuration, the internal resistor may be used on the **end positions only**. In this configuration, the **end** ATM60-D should have their bus termination DIP switches turned ON.

10.4.4 Electronic adjustment (PRESET-Function)

The ATM60-D encoder supports an electronic adjustment to a predefined value (Factory PRESET value is zero [0]. -- The adjustment can be carried out in 2 ways:

- Operate the push-button S4 located under the screw cover of the bus connector.
- Via the DeviceNet protocol.

The PRESET function is not intended for use in dynamic parameter setting operations but as an electronic adjustment function during commissioning, in order to allocate a specific value to the mechanical rotary position of the encoder.

Using the PRESET function results in a change of position reading. This can cause unexpected motion which could result in damage to the product, equipment or personal injury.

The present physical position value is saved as the "Offset value" [Attr. 91] to the EEPROM, and the new value then applies to the position currently assumed.

10.4.4.1 Adjustment using the push button

- Switch on the voltage.
- Set the drive shaft, with the encoder mounted, to the mechanical zero position.
- Remove the cover from the back of the encoder and press the button with a suitable blunt and non-conducting object for at least 100 ms. -- Refit the cover.

10.4.4.2 Adjustment using the DeviceNet protocol

Program your master device using an explicit message to the attribute "PRESET Value" of the encoder object. -- See 8.5.1 (DeviceNet Messaging...).

The PRESET value must be within the total working range currently configured as CMR.

10.5 Display element / Network status LED

The device includes the network status LED (NS) according to the DeviceNet specification. This built-in bi-color LED (red/green) is in the bus connector housing, and indicates the status of the communication link.

LED	Status	Description
Off	Not Powered / Not On-Line	Device is not Online - Duplicate MAC-ID check not complete - No power supply
Flashing Green	On-Line / Not Connected	Device is online, but no Connection is established - Duplicate MAC-ID check has passed - Device is not allocated to a master (Group 2 Only device)
Green	On-Line / Connected	Device is online and has connections in the established state - Device is allocated to a master (Group 2 Only device)
Flashing Red	Connection Time Out	One ore more I/O Connections are in the Timed Out state. - (Minor fault)
Red	Critical Link Failure Time Out	Failed communication device. - Device has detected an error (Duplicate MAC-ID, Bus-Off). - (Major fault)

11 Putting into Operation

To continue, the following conditions are required:

- The encoder is attached correctly.
- The node address and data rate are set according to your network specification.
- The encoder specific parameters are configured according your application.

The procedure at these settings are described in the chapter 9 ("Commissioning of the device) and 10 ("Connecting..."). .

> Before putting the encoder into operation you must have read chapter "Safety Regulations".

11.1 Modes of Operation

The ATM60-D has the following operating modes:

- Power-up / Reset Mode
- Run Mode
- Error Mode

During a power-up or reset mode, the ATM60-D:

- Performs diagnostic tests including EEPROM Test, Self-Test.
- Reads the MAC ID setting. Performs Duplicate MAC ID Check.

> DIP switches are only read in Reset Mode

11.2 Turn-On Characteristic of the Encoder

The network Access State machine implemented in all devices describes task that must be performed prior to communicating. After Power-On a sequence according the Network Access state Transition Diagram is passed.

LED	Status	Description	
Flashing Red, Green	"*Self-Test*" sequence	**Reset Mode**: -- (part 1)	1 sec
OFF	"Duplicate MAC ID Check Request"	**Reset Mode**: -- (part 2)	2 sec
Flashing Green	*On-Line* State **(*)**	**Run Mode**: -- Slave can be allocated by a master device.	**(*)** only one of them selected
Solid Red	Communication Fault State **(*)**	**Error Mode**: -- Error has occurred in the previous state.	

While "*Self-Test*" sequence (LED is flashing green and red in cycles of 250 MS), the encoder specific data are transferred from the EEPROM into the RAM part. Also the objects used by the DeviceNet Model are initialised. A failure by reading the EEPROM values is recognised, and results in setting the "Alarm Flag" (see 7.7.4, Alarms).

After "*Self-Test*" sequence has terminated, the device sends two identical consecutive "*Duplicate MAC ID Check Request*" messages within a distance of one second. These messages contain the Vendor ID (two byte) and the device identification (4 byte unique Serial Number).

The following table illustrates the message, sent by a module with a MAC ID of $3F_H$ (63), and the Vendor ID assigned to *Stegmann* (511_{dez}).

Identifier (bit 10...0)			Data (8 Byte)				←			
Gr	MAC ID	MSG ID	Head	Data_0	Data_1	Data_2	Data_3	Data_4	Data_5	Data_6
10	1.1111-1	111	00	FF	01	SN_Lo	...	...	SN_Hi	

Identifier	$5.FF_H$
MSG ID	[07]: Duplicate MAC ID Check Message
Head	Port Number: [**0**xxx-xxxx]$_B$ Request Message, [**1**xxx-xxxx]$_B$ Response Message
Data_0..._1	Vendor ID (Low Byte, High Byte):): -- Stegmann [**01.FF**]$_H$
Data_2..._5	**(*1)** Serial Number (Low Byte...High Byte)

(*1) More detail to the encoding of the Serial Number, see <u>*Appendix A*</u>.

While Reset Mode is executed and the device receives any "DUP MAC ID Check Request/ Response" messages or a *CAN Bus-Off* was detected, it enters Error Mode (*Communication Fault* State). If no error has occurred, the encoder enters run mode and operates as a slave device to a master device.

> To exit Error Mode with a Critical Error (Non-Recoverable), cycle power to the unit or disconnect the DeviceNet Cabling.

11.3 Run Mode / Connection to Master Device

The encoder ATM60-D are designed to perform some predetermined functions (provides input data / requires output data and configuration data). For this purpose, the encoder supports the "*Predefined Master / Slave Connection Set*". This is the easiest way to implement a predefined number of connections.

To start the interchange of data, a master device only have to claim ownership of this predefined connection set, as soon as the encoder changes into Run Mode (*On-Line* State).

The master device must establish at least one explicit connection and one I/O connection to the encoder by using the specified DeviceNet messaging protocol.

A simple configuration program to get the encoder into operation is shown in <u>*Appendix B*</u>

- **A:** Sequence of a "*Duplicate MAC ID Check Request*" initiated by the slave.
- **B:** Allocation of the Predefined_Master / Slave_Connection Set with one explicit and one I/O connection (Polling). -- Establish the explicit message connection.
- **C:** The I/O connection (ID=2) is configured to assembly instance number two (2), transmitting 8 bytes of I/O data (position value + velocity value).
- **D:** Establish the I/O connection to "No terminating" (value = [00.00]).
- **E:** Start the Polling sequence with a cycle time of 50 MS. The receive message contains 4 byte of position value and 4 byte of velocity value.
- **F:** Release the Predefined_Master / Slave_Connection Set.

For further details see also section 8.3 (Connecting to the DeviceNet encoder).

12 Problem Solving

DeviceNet will not function correctly if design rules are not followed. Even a network previously thought to be functioning correctly may begin to exhibit anomalous operation due to incorrect system design.

To solve problems that can occur, you need to understand the physical DeviceNet layout, the devices on the network and how all pieces work together.

Diagnostic tools and device indicators help identify the operational state of devices and network communication problems.

12.1 Cable Installation and Design Problems

Cable installation and design has to do with the physical layout and connections on the network. Walk the network if possible to determine the actual layout.

Ensure that you have a diagram of the physical layout and a record of the following information on the layout.

- Number of nodes.
- Individual, branched and cumulative drop lengths.
- Total trunk length, including long drop near the ends.
- Power supply cable length and gauge.

- Terminator locations and size.
- Break the earth ground of the V- and Shield and verify >1.0 MOhm to frame ground with power supply off.
- Check for short circuits between CAN_H and CAN_L, or CAN_(H, L) to Shield, V-, V+.
- Length and gauge of the earth ground connection.
- Total power load and its distribution points.

12.2 LED Status Check

The Network Status LED shows the status at power-up and during operation of the network.

LED	Status	Indicates	Action
Off	• Not Powered • Not On-Line	• No power to device • Failed Duplicate MAC ID check	• Check that one or more nodes are communicating on the network • Check that at least one other node on the network is operational and the data rate is the same as the ATM60-D
Flashing Green	• On-Line • Not connected	• Passed Duplicate MAC ID check • And No connection established	• No action is needed. The LED is flashing to signify that there are no open communication connections between the ATM60-D and any other device. Any connection (IO or explicit message) made to the encoder will cause the LED to stop flashing and remain Steady-ON for the duration of any open connection.
Steady Green	• On-Line • Connected	• One or more connections established	• No action is needed.
Flashing Red	• On-Line • Time-Out	• At least one IO connection has timed out	• Re-initiate IO messaging by master controller • Reduce traffic or errors on the network so that messages can get through.

LED	Status	Indicates	Action
Steady Red	• Network Failure	• Failed Duplicate MAC ID check • Bus-OFF	• Ensure that all nodes have unique addresses. • If all node addresses are unique, examine network for correct media installation. • Ensure that all nodes have the same data rate.

If the Network Status LED goes Steady-Red at power-up, it could mean there is a Duplicate MAC ID. The user response should be to test all devices for unique addresses. If the symptom persists, it means a Bus-OFF error.

- Check data rate settings.
- If symptom persist, replace node address (with another address and correct data rate).
- If symptom persists, check the topology.
- If symptom persists, check power for noise.

12.3 Scanner Problems

If using a scanner, check the scan list, data rate and addresses of devices. Verify series and revision of the scanner.

If the scanner goes Bus-OFF after a reset the problems is some combination of:

- defective node device.
- incorrect node data rate.
- bad network topology.
- faulty wiring.
- faulty scanner.
- faulty power supply.
- bad grounding and / or electrical noise.

12.4 Wiring Problems

Various situations in and around cables can cause problems on the network. Things to do are:

- check that connectors and glands are screwed tightly.
- check connectors for contamination by foreign materials.
- check that nodes are not touching extremely hot or cold surfaces.
- check that cables are kept a few inches away from power wiring.
- check that cable are not draped on electrical motors, relays, contactors or solenoids.
- check that cables are not constrained so as to place excessive tension on connectors.

12.5 Power Supply Problems

Add up the current requirements of all devices drawing power from the network. This total should be the minimum current rating in selecting the power supply used. In addition check:

- length and current level in trunk and drop cables.
- size and length of the cable supplying power to the trunk.
- voltage measured at the middle and ends of the network (see also "Common Mode Voltage" -- *Appendix C*).

12.6 Adjusting the Physical Network Configuration

Some ways to help improve the efficiency of your physical network configuration are:

- Shorten the overall length of the cable system.
- Move the power supply in the direction of an overloaded cable section.
- Move higher current loads closer to the power supply.

- Add another power supply to an overloaded network.
- Move the power supply from the end to the middle of the network.

12.7 Points to remember

- Pressing the reset button on the scanner does not reset the network.
- Cycling power on the network can cause the scanner to go Bus-OFF.
- On some DeviceNet nodes (such as photoelectric sensors) the Bus-OFF (solid red) condition can be cleared by cycling the 24V power or by pressing a reset button once or twice.
- Extreme care must be given to the task of setting initial addresses and baud rates because one incorrect node can cause other nodes to appear to be bad (solid red).
- If the scanner is Bus-OFF, nodes will not necessarily reallocate (they will stay flashing green or red) even if they are functioning correctly.
- DeviceNet management and diagnostic tools can be used to identify the functioning nodes on the network, and their type. When devices are reset or re-power they will transmit two Duplicate MAC-ID Check Request messages which provide a convenient method of verifying baud rate, MAC-ID, Vendor ID, and Serial Number of the device.
- If a node goes Bus-OFF (solid red indicator), and is replaced and still goes Bus-OFF, the problem is not the node but rather the setting of the address or data rate OR a network wide problem related to topology, grounding, electrical noise or an intermittent node.
- Intermittent power connections to nodes will provoke frequent (but perhaps incomplete) duplicate MAC-ID checks and possibly cause other nodes to go Bus-OFF.
- Intermittent data connections to a strobed node will cause corrupted frames that also may cause other nodes to go Bus-OFF. The source of the difficulty may be far from the node which evidences the symptom.

13 Technical Description

13.1 General

The ATM60-D is a true absolute multiturn magnetic encoder offering advanced functionality for position feedback. The encoder can be connected to the network via direct cable connection or five pin micro quick-disconnects. The ATM60-D can be configured to provide up to 8.192 counts per revolution and a maximum of 8.192 revolutions. The revolutions are determined by the use of a gear mechanism. This encoder incorporates advanced diagnostic and many programmable options.

The bus interface is an integral part of the encoder and is configured as a "Group 2 Only Server", according to the DeviceNet specification (Release 2.0). -- The ATM60-D is Conformance Tested and Certified by ODVA.

The implementation of the different functions is realised according to the “Profile for Encoder“.

13.2 Features

The features of the ATM60-D in brief:

- Magnetic Technology allows high shock and vibration
- Wide operating temperature range (-40 °C to 100 °C)
- 26 bit multiturn absolute encoder retains position data if power is lost.
- Up to 8.192 CPR and 8.192 turns.
- Electrical interface according to ISO 11898
- Electrical insulation of the DeviceNet interface
- Compact dimensions
- Configuration by means of hardware settings (DIP switches) in the bus connector housing:
  - Electronic adjustment (Number-SET) via push-button
  - Address setting (NODE ID)
  - Setting transmission rate (Data Rate)
  - Bus termination
- Show status of the communication link via LED (NS) in the bus connector housing.
- Configurable parameters of the Encoder Object via the DeviceNet protocol:
  - **Encoder basic parameters**: Counting direction, scaling function control, CPR, CMR, PRESET Value, position change required for COS communication.
  - **Encoder extended functions**: working area range, Min/Max velocity and acceleration.
  - **One Channel with 8 programmable Cams**: high/ low limits and hysteresis.
  - **Manufacturer specific**: Assembly selection to configure the IO data composition.
- Support of the following I/O Slave Messaging (as an Input Device):
  - Polling
  - Change of State (COS) / Cyclic
  - Bit Strobe
- Simultaneous configuration of all I/O messaging by different assembly instances.
- Generates a new position value in **intervals of approx. 0,250 ms**.

13.3 Specification according DIN 32 878

Data and variables	Face mount/ Servo-flange	Hollow shaft design	Units
Dimensions	see drawings		
Weight	about 0,590		kg
Moment of Inertia of the Rotor	35	55	gcm^2
Measuring Step	0,043		Degrees
Max. Number of Counts / Revolution	8192		
Max. Number of Revolutions	8192		
Error Limits	± 0,25		Degrees
Repeatability	0,1		Degrees
Working Speed	6000	3000	min-1
Position Forming Time	0,250		ms
Max. Angular Acceleration	5×10^5		rad/s^2
Operating Torque with shaft sealing ring	1,8	0,8	Ncm
Operating Torque w/o shaft sealing ring	0,3	-	Ncm
Starting Torque with shaft sealing ring	2,5	1,2	Ncm
Starting Torque w/o shaft sealing ring	0,5	-	Ncm
Max. Shaft Loading Radial / Axial	300 / 50	-	N
Permissible Shaft Movement of the drive element			
Radial Static / Dynamic	-	± 0,3 / ± 0,1	mm
Axial Static / Dynamic	-	± 0,5 / ± 0,2	mm
Bearing Lifetime	$3,6 \times 10^9$		Revol.
Temperature (working range)	-20 ... + 85		°C
Temperature (operating range)	-40 ... +100		°C
Temperature (storage range)	-40 ... +125		°C
Permissible relative air humidity	98		%
EMC according to EN 50 081-2 and EN 50 082-2, CE			
Resistance to Shock (mounted state) -- IEC 68-2-27	100 / (6 ms)		g
Resistance to Vibration (mounted state) -- IEC 68-2-6	20 / (10..2000Hz)		g
Protection Class to EN 60 529			
with shaft sealing ring	IP 67	IP 67	
w/o shaft sealing ring, not sealed at encoder flange	IP 43	IP 43	
w/o shaft sealing ring, sealed at encoder flange	IP 66	-	
Operating Voltage	10 - 32		V
Max. Power Consumption	2,0		W
Initialisation Time	1250		ms

Bus Interface DeviceNet		
Electrical Interface	ISO 11898 (CAN High Speed) to CAN Specification 2.0 B, DC isolated	
Protocol	DeviceNet Specification, Release 2.0	
Address Setting (NODE ID)	0...63	via DIP switches or protocol
Data Transmission Rate (Data Rate)	{125, 250, 500 } kb	via DIP switches or protocol
Electronic Adjustment (Number SET)	via PRESET push button or protocol	
Status Information	Network Status LED (NS), 2 colours	
Bus Termination	via DIP switches (used on the end positions only)	
Electrical Connection	Screw fitting / Cable gland with PG-9, or M12 circular plug-in connector, (5 pin micro-style)	

14 Drawings

14.1 Types of Encoders

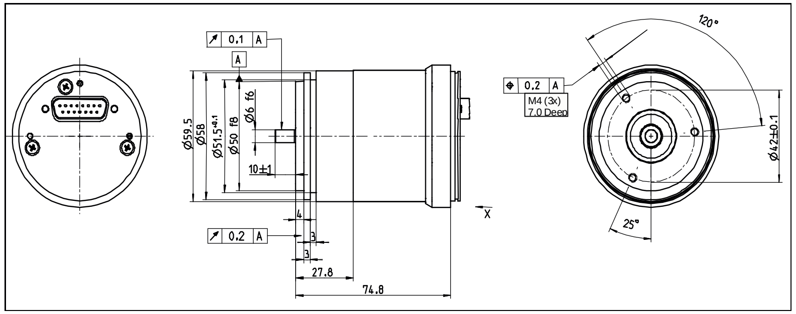


Figure 14–1: Encoder ATM60-D (servo flange)

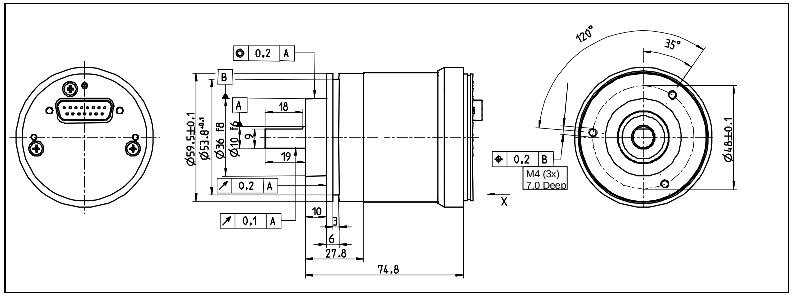


Figure 14–2: Encoder ATM60-D (face mount flange)

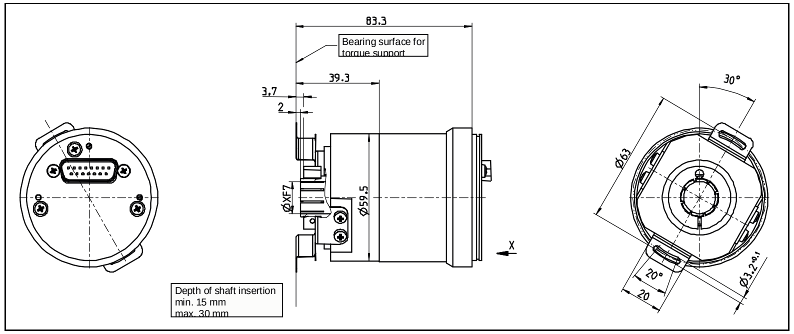


Figure 14–3: Encoder ATM60-D (blind hollow shaft)

14.2 Types of DeviceNet adaptors

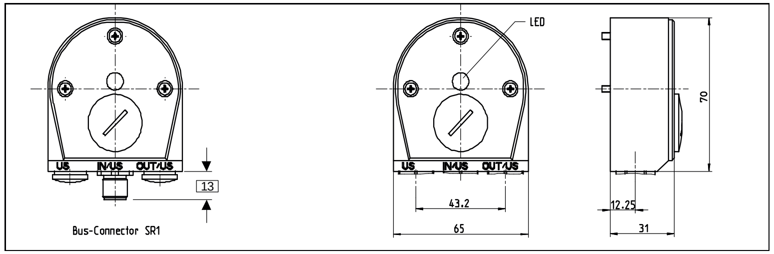


Figure 14–4: DeviceNet adaptor SR1 (circular plug-in connector)

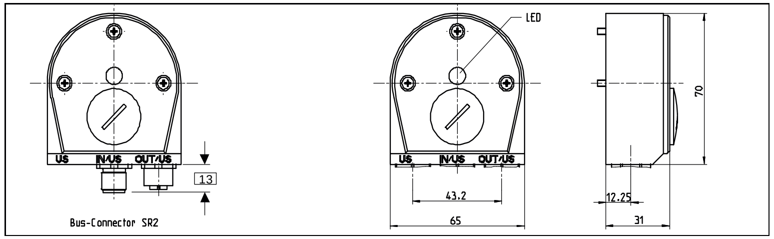


Figure 14–5: DeviceNet adaptor SR2 (circular plug-in connector)

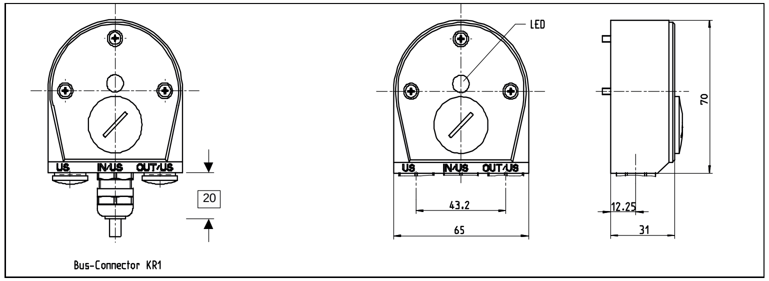


Figure 14–6: DeviceNet adaptor KR1 (Cable Termination, using PG-9)

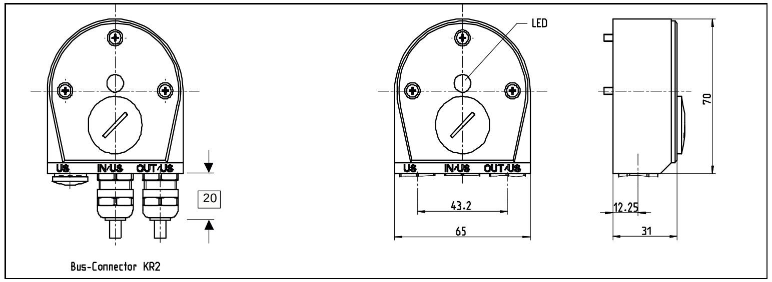


Figure 14–7: DeviceNet adaptor KR2 (Cable Termination, using PG-9)

. Appendix A

Encoding of the Stegmann Serial Number according DeviceNet Specification

All vendors that produce DeviceNet nodes will be assigned a Vendor Identification Code. In addition, each Vendor must assign every DeviceNet product a unique 32-bit serial number when manufacturing the product. The Serial Number need only be unique with respect to a particular vendor. This identification code is part of the "Duplicate MAC ID Check Request Message".

View of the 4 Byte Identification Code:

Byte_3 (MsB)		Byte_2		Byte_1		Byte_0 (LsB)	

The internal identification (serial number) used by Stegmann consist of 9 characters (ASCII-Code) with the following meaning:

U	D1	D2	D3	D4	D5	D6	D7	D8

U	Unused
D1...D8	Internal number (Ascii-Code) "31" --> [01]

The internal Ascii-Code specifies a number range from "30...39" and "41....46" according to the number [0 ... 9] and [A ... F].

The digits D1, D2 (Byte_3) are used as a vendor specific identifier, different to each manufacturer of this device type:

- Stegmann Donaueschingen
- Stegmann USA
- A-B

Example:

The internal serial number

U	30	31	33	34	38	39	41	46

is converted into a 4 Byte identification code (Hex format):

Byte_3 (MsB)		Byte_2		Byte_1		Byte_0 (LsB)	
0	1	3	4	8	9	A	F

View of the 4 Byte Identification Code according a data mapping in format "Little Endian" used by the DeviceNet transmission protocol.

Byte_0 (LsB)		Byte_1		Byte_2		Byte_3 (MsB)	
A	F	8	9	3	4	0	1

. Appendix B

Configuration program to get the encoder into operation.

```
Begin Triggerblock Tue Oct 16 14:36:40 2001 -- (base hex)
// Time | ID | Attr Gr | SM DM | MId | XF Serv | Data
A
//10.6394 1 5FF Rx 2 3F 07 Rq 'Dupl.MAC check' Serial D903039 Port 00 Vendor1FF
 10.6394 1 5FF Rx d 7 00 FF 01 39 30 90 0D
//11.6399 1 5FF Rx 2 3F 07 Rq 'Dupl.MAC check' Serial D903039 Port 00 Vendor1FF
 11.6399 1 5FF Rx d 7 00 FF 01 39 30 90 0D
B
//13.2929 1 5FE Tx 2 01 3F 06 0 Rq 'Alloc Master/Slave' Cl3(DNet) Ins1 Choice Ex|Pl Master
1
 13.2929 1 5FE Tx d 6 01 4B 03 01 03 01
//13.2933 1 5FB Rx 2 3F 01 03 0 Rsp 'Alloc Master/Slave' DN8/8
 13.2933 1 5FB Rx d 3 01 CB 00
//13.8684 1 5FC Tx 2 01 3F 04 0 Rq 'Set Attr Single' Cl5(Cnxn) Ins1 Atr9(exPRate) :00 00
 13.8684 1 5FC Tx d 7 01 10 05 01 09 00 00
//13.8688 1 5FB Rx 2 3F 01 03 0 Rsp 'Set Attr Single' :00 00
 13.8688 1 5FB Rx d 4 01 90 00 00
C
//14.4080 1 5FC Tx 2 01 3F 04 0 0 Rq 'Set Attr Single' Cl5(Cnxn) Ins2 AtrE(prdCnPath)
 14.4080 1 5FC Tx d 6 81 00 10 05 02 0E
//14.4084 1 5FB Rx 2 3F 01 03 0 0 Rsp Fraq: Success
 14.4084 1 5FB Rx d 3 81 C0 00
//14.9866 1 5FC Tx 2 01 3F 04 0 1 :20 04 24 03 30 03
 14.9866 1 5FC Tx d 8 81 81 20 04 24 03 30 03
//14.9869 1 5FB Rx 2 3F 01 03 0 1 Rsp Fraq: Success
 14.9869 1 5FB Rx d 3 81 C1 00
//14.9871 1 5FB Rx 2 3F 01 03 0 Rsp 'Set Attr Single'
 14.9871 1 5FB Rx d 2 01 90
D
//15.7201 1 5FC Tx 2 01 3F 04 0 Rq 'Set Attr Single' Cl5(Cnxn) Ins2 Atr9(exPRate) :00 00
 15.7201 1 5FC Tx d 7 01 10 05 02 09 00 00
//15.7205 1 5FB Rx 2 3F 01 03 0 Rsp 'Set Attr Single' :00 00
 15.7205 1 5FB Rx d 4 01 90 00 00
E
//17.1869 1 5FD Tx 2 3F 05 Rq IO Poll
 17.1869 1 5FD Tx d 0
//17.1873 1 3FF Rx 1 3F 0F Rsp IO Poll :A1 21 00 00 00 00 00 00
 17.1873 1 3FF Rx d 8 A1 21 00 00 00 00 00 00
//17.2380 1 5FD Tx 2 3F 05 Rq IO Poll
 17.2380 1 5FD Tx d 0
//17.2385 1 3FF Rx 1 3F 0F Rsp IO Poll :A1 21 00 00 00 00 00 00
 17.2385 1 3FF Rx d 8 A1 21 00 00 00 00 00 00
//17.2891 1 5FD Tx 2 3F 05 Rq IO Poll
 17.2891 1 5FD Tx d 0
//17.2895 1 3FF Rx 1 3F 0F Rsp IO Poll :A1 21 00 00 00 00 00 00
 17.2895 1 3FF Rx d 8 A1 21 00 00 00 00 00 00
F
//26.0870 1 5FE Tx 2 01 3F 06 0 Rq 'Release Master/Slave' Cl3(DNet) Ins1 RelChoice Ex :01
 26.0870 1 5FE Tx d 6 01 4C 03 01 01 01
//26.0872 1 5FB Rx 2 3F 01 03 0 Rsp ?'Release Master/Slave'
```



```
 26.0872 1 5FB Rx d 2 01 CC
End Triggerblock
```

. Appendix C

Common Mode Voltage

When current is drawn through the power pair on the DeviceNet trunk line, the length of the cable and current draw becomes important. The thick wire, normally used for trunk line, has a resistance of 0.0045 Ohms/ foot. So as the distance from the DeviceNet power supply connection becomes greater, the power pair will act as a resistor whose value will be equal to 0.0045 multiplied by the Distance from the Power Supply (In Feet). At any particular point on the power pair the Common Mode Voltage will equal the Current being drawn on the power pair at that point times the Resistance of the Power Pair. (V = I x 0.0045 x Distance)

The effect of the Common Mode Voltage is that the V+ line will lower gradually from the 24VDC at the power supply as you move farther down the trunk line. More importantly the V- wire will gradually raise from the 0VDC value at the power supply along the length of the trunk line. On most networks the amount of voltage the V+ lowers and V- raises are equal. So even though there may be exactly 24VDC measured at Network Power Supply, further down the cable the voltage on the V+ and V- wires may only be 20VDC. This effect is due to Common Mode Voltage and should the voltage drop become too large the network will fail to operate properly. Since the CAN-H (White Wire) and the CAN-L (Blue Wire) both are referenced to the V- wire, if the V- line varies more than 4.65VDC at any two points on the network the CAN transceivers will fail to operate properly.

An easy way to measure for Common Mode Voltage problems is to go to the farthest ends of the network and measure between Red V+ and Black V- wires. This voltage should NEVER be less than 15 Volts.

Network Voltage/ OHM Readings

It needs to be understood that DeviceNet is actually a three wire Differential Voltage network. Communication is accomplished by switching the CAN-H (White wire) and CAN-L (Blue wire) signals relative to the V- line (Black Wire).

Important NOTE

The CAN to V- voltages given in the rest of this chapter assume **NO Common Mode Voltage** effect is occurring anywhere on the V- wire of the network. On a network with Common Mode Voltage influence, the voltages will be higher depending on where you take the measurement. Nodes closest to the power supply will exhibit voltages higher due to the Common Mode Voltage, while nodes at the farthest end of the network away from the power supply will exhibit lower voltages.

The CAN-H swings between 2.5 VDC (Recessive State) and 4.0 VDC (Dominant State) while the CAN-L swings between 1.5 VDC (Dominant State) and 2.5 VDC (Recessive State)

Without a network master connected to the DeviceNet, the CAN-H and CAN-L lines should read between 2.5 VDC and 3.0 VDC relative to V- and the voltages should be identical (Recessive State). Measure these voltages right at the SDN scanner connection which is normally also where the power supply is connected to the network. Use a voltmeter in DC mode.

With a network master connected to the DeviceNet **and polling the network,** the CAN-H to V- voltage will be around +3.2 VDC. The CAN-L to V- voltage will be around 2.4 VDC. The reason these values appear a little different than the ranges shown on the scope trace, is that the signals are switching, which slightly affects the DC value being read by the VOM.

With the 24VDC power supply not energised you can measure the resistance between the CAN-H and CAN-L signals. The ohm reading between the CAN-H and CAN-L lines should be 60 ohms (two 120 ohm resistors in parallel), however with a large amount of devices connected to the network the resistance could be as low as 50 Ohms.

. Directory of Figures

. Notes